United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. S.E., Suite 102
Lacey, Washington 98503

In Reply Refer to:
FWS/R1/2022-0048454

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

Dear Mr. Tillinger

Subject: Programmatic Consultation for NWS-2022-301, Salish Sea Nearshore Programmatic (SSNP)

This letter transmits the U. S. Fish and Wildlife Service's (USFWS) Biological Opinion on the proposed Salish Sea Near Shore Programmatic Consultation addressing U.S. Army Corps of Engineers permitting activities located in the marine nearshore of Puget Sound, Hood Canal and the Strait of Juan de Fuca in Washington State (hereinafter, Salish Sea), and its effects on marbled murrelet (*Brachyramphus marmoratus*) and bull trout (*Salvelinus confluentus*), and critical habitat for the bull trout. Formal consultation on the proposed action was conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). We received your request for formal consultation by email on April 11, 2022.

The enclosed Biological Opinion is based on information provided in the April 11, 2022, Proposed Action and request for consultation, meetings and conversations with the U.S. Army Corps of Engineers and National Marine Fisheries Service and other sources of information cited in the Biological Opinion. A complete record of this consultation is on file at the USFWS Washington Ecological Service Office in Lacey, Washington. An electronic copy of this Biological Opinion will be available to the public approximately 14 days after it is finalized and signed.

PACIFIC REGION 1

IDAHO, OREGON*, WASHINGTON,
AMERICAN SAMOA, GUAM, HAWAII, NORTHERN MARIANA ISLANDS

*PARTIAL

If you have any questions regarding the enclosed Biological Opinion, our response to your concurrence request(s), or our shared responsibilities under the Act, please contact Curtis Tanner at curtis_tanner@fws.gov.

Sincerely

CURTIS TANNER

Digitally signed by CURTIS TANNER
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for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

Enclosure(s)

cc:
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NMFS, Seattle, WA (E. Murray)
NMFS, Portland, OR (K. Kratz)
USFWS, Portland, OR (E. Teachout)
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Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
2022-0048454

Salish Sea Nearshore Programmatic for Actions Authorized by the U.S. Army Corps of Engineers

Washington

Federal Action Agency:
U.S. Department of Defense, Department of the Army
Seattle District, U.S. Army Corps of Engineers
4735 E. Marginal Way South
Seattle, Washington 98134-2388

Consultation Conducted By:

U.S. Fish and Wildlife Service
Washington Fish and Wildlife Office
Lacey, Washington

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for Brad Thompson, State Supervisor
Washington Fish and Wildlife Office

Date

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ACRONYMS AND ABBREVIATIONS

AA	Action Area
ABA	Architectural Barriers Act of 1968
ACZA	arsenate ammoniacal copper zinc arsenate
ADA	Americans with Disabilities Act of 1990
BMP	Best Management Practices
CCA	chromated copper
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH	confidence interval
CHU	Critical Habitat Unit
CI	confidence interval
CWA	Clean Water Act
DAM	destruction or adverse modification
dB	decibel
dBA	A-weighted decibel level
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ENSO	El Niño-Southern Oscillation
ESA	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
FMO	Foraging, Migration and Overwintering
FR	Federal Register
GCM	general construction measures
GHG	greenhouse gas
HAT	Highest Astronomical Tide
HCP	Habitat Conservation Plan
HDD	horizontal directional drilling
HDPE	high-density polyethylene
HTL	high tide line
IRU	Interim Recovery Unit
km^2	square kilometers
LID	Low Impact Development
LVAP	Lower Vertical Adjustment Potential
MLLW	mean lower low-water
MMMP	Memorandum of Understanding
Navy	U.S. Navy

ACRONYMS AND ABBREVIATIONS

NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWFPEM	Northwest Forest Plan Effectiveness Monitoring Program
NWTT	Northwest Training and Testing
OHWM	Ordinary High Water Mark
Opinion	Biological Opinion
OWS	overwater structure
PAH	Polycyclic Aromatic Hydrocarbons
PBDE	polybrominated diphenyl ethers
PBF	Primary Biological Factors
PCBs	Polychlorinated Biphenyls
PCE	Primary Constituent Element
PCSMP	Post-Construction Stormwater Management Plan
PDC	project design criteria
PDC	project design criteria
PDO	Pacific Decadal Oscillation
PRF	piers, ramps, and floats
PSP	Puget Sound Partnership
PST	petrolatum saturated tape
PVC	polyvinyl chloride
RHA	Rivers and Harbors Act
RVPP	riparian vegetation planting plan
SAV	submerged aquatic vegetation
SEL	sound exposure level
Services	U.S. Fish and Wildlife Service and National Marine Fisheries Service
SPL	sound pressure levels
UIC	underground injection control
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

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1 INTRODUCTION

This document represents the U. S. Fish and Wildlife Service's (USFWS) Biological Opinion (Opinion) based on our review of the proposed Salish Sea Nearshore Programmatic located in marine waters of Washington State. The Opinion addresses effects to bull trout (Salvelinus confluentus), marbled murrelet (Brachyramphus marmoratus) and designated critical habitat for the bull trout in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA). We received your request for consultation on April 11, 2022.

This Opinion is based on information provided in the proposed action and additional information provided on April 11, 2022, and additional conversations with staff from the U.S. Army Corps of Engineers (Corps) and National Marine Fisheries Service (NMFS) as detailed below. A complete record of this consultation is on file at the USFWS' Washington Fish and Wildlife Office in Lacey, Washington.

2 CONSULTATION HISTORY

The following is a summary of important events associated with this consultation:

> In 2019, NMFS and the USFWS (jointly, the Services) began working with the Corps to identify a set of routine activities permitted by the Corps within the Salish Sea that could be addressed through a programmatic consultation. This action is referred to as the Salish Sea Nearshore Programmatic Consultation (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, resolved questions about principles for the consultation. On January 7, 2022, NMFS and the Corps resumed development of SSNP consistent with the Joint Memo and existing legal requirements. USFWS joined discussions in early February 2022.
>
> During development of the proposed action, the Services and the Corps exchanged drafts of the proposed action for review. On April 8, 2022, NMFS, USFWS, and the Corps agreed on a programmatic action for the Salish Sea Nearshore Programmatic Consultation (SSNP).
>
> The Corps, NMFS and USFWS held public meetings to provide an overview of activities covered in the programmatic on March 30 and 31, 2022.
>
> The request for consultation including the detailed proposed action was received on April 11, 2022, after several weeks of workgroup meetings between the Corps, NMFS, and the USFWS refining the proposed action and covered actions.

As part of the consultation process, from April 11 to May 3, 2022, the Corps and the Services made minor revision to the proposed action for SSNP. A general construction measure was added for rescuing listed fish within areas isolated for in-water work and criteria were added for placement of spawning material for forage fish.

On May 18, 2022, NMFS shared a draft of its opinion with the Corps and USFWS.

On June 29, 2022, NMFS finalized their Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for SSNP.

USFWS shared a draft of its opinion with the Corps and NMFS on July 8, 2022.

3 BIOLOGICAL OPINION

4 DESCRIPTION OF THE PROPOSED ACTION

A federal action means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas (50 CFR 402.02) (2018).[1]

4.1 Background and History

In 2019, the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS) and the U.S. Army Corps of Engineers, Seattle District (Corps) began development of a programmatic consultation to address Corps permitted activities in the nearshore of the Salish Sea in Washington State. Further interagency coordination and discussion occurred in order to address how the Corps Regulatory Program reviews an applicant's proposed project request for discharges or work associated with existing structures under Section 7 of the Endangered Species Act (ESA) in order to proceed with this programmatic consultation.

As a result of the further interagency review, a *Memorandum Between the Department of the Army (Civil Works) and the National Oceanic and Atmospheric Administration (NOAA)* (Joint Memo), dated January 5, 2022, was issued to provide guidance. Following the Joint Memo, both agencies resumed efforts to develop a programmatic consultation to address Corps proposed permit actions focused on activities within the Salish Sea, as defined in Section 5 (Project Design Criteria for Covered Activities) of this document. On January 7, 2022, NMFS and the Corps resumed development of the Salish Sea nearshore programmatic consultation in accordance with the Joint Memo. The USFWS joined the effort in early February 2022, and the three agencies agreed to develop aligned programmatic consultations that would streamline the ESA consultation process for activities regulated by the Corps in the Salish Sea nearshore area.

4.2 Purpose And Objectives

The Secretary of the Army, acting through the Corps, is responsible for administering a regulatory program (33 Code of Federal Register (CFR) 320-332) that prohibits certain activities in waters of the United States until permits 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 (33CFR 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

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[1] Citations to the 50 C.F.R. Part 402 regulations in this Opinion are to the regulations in effect in 2018, prior to the changes adopted in 2019 that were vacated by the district court in Ctr. for Biological Diversity v. Haaland, No. 19-CV-05206-JST, 2022 WL 2444455 (N.D. Cal. July 5, 2022). Determinations in this Opinion as to whether the action jeopardizes listed species or adversely modifies critical habitat are the same whether analyzed under the 2018 regulations now in effect, or the regulations modified in 2019 that were vacated.

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. 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 Salish Sea Nearshore Programmatic (SSNP) is a consultation framework developed by the NMFS, USFWS, and Corps for programmatic ESA and Essential Fish Habitat (EFH) consultation. The programmatic consultation framework includes a set of activity categories and specifies design criteria for those activities that, when implemented: (1) help avoid and minimize adverse effects of the categories on listed species and their critical habitat; (2) provide parameters for eligible activities 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 activities under the CWA and RHA where applicants propose activities that fall within the SSNP's described activity categories and applicants have agreed to implement the applicable design criteria from SSNP.

4.2.1 Activity Categories

Work covered by SSNP is limited to the categories of activities described in Table 1, provided the applicant complies 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 further 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 included in SSNP often involve elements or activities that are not under the 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 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 that action, certain anticipated aspects of activities that may not be under the jurisdiction of the Corps, are 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 an effect of the action and is reasonably certain to occur due to the need for equipment staging for purposes of this programmatic consultation. Hence, there are design criteria regarding riparian vegetation removal. The Corps does not regulate activities occurring outside its 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 when required under a Section 7 consultation. In addition, if an activity is not within the Corps' regulatory authority but results in a "take" of listed species as defined by the ESA and its implementing regulations, the applicant may be subject to penalties, enforcement actions, and other actions under Section 11 of the ESA.

The proposed action for SSNP includes: (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 or replaced under SSNP, the proposed activity generally results in an extension of the 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. 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:

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 unnecessary (i.e., prior to the enactment of the CWA in 1972).

If the Corps has previously issued a permit for the structure, that permit authorized the structure with no end date. 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 authorized structures (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 an additional Corps permit (not sought at this time) 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.

The Corps has the discretion to grant or deny requests for Regulatory permits to conduct activities that would be covered under SSNP. *See* Section 4(b) of 2022 Memorandum between the Department of the Army (Civil Works) and the National Oceanic and Atmospheric Administration.[2]

Applicants typically seek Corps authorization to repair or replace existing structures before their structure is in need of major repairs, but not so soon as to incur unnecessary expenses. 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 Programmatic (NMFS 2016a), and accounts for the time a 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.[3]

Nearly all repair or replacement projects covered by SSNP will cause the existing structures to exist into the future longer that they otherwise would have. 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:[4]

Over and in water structures: 40-years

Shoreline stabilization (marine bulkheads): 50-years

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

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[2] *Available at* https://www.fisheries.noaa.gov/resource/document/army-and-noaa-joint-resolution-memorandum-evaluating-effects-projects-involving, last visited April 28, 2022.

[3] 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.

[4] 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.

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.

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 permitees 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 effect of the activities that will be covered by SSNP is to extend the life of 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.

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. 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 Habitat Conservation Calculator (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 through an individual ESA consultation and will undergo a project-specific analysis.

Table 1. Summary of Covered Activities. Additional details and requirements found in the Section 5, 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/or replacement resulting in improved fish passage</td></tr>
<tr><td>Utilities</td><td>PDC #2</td><td colspan="2">Relocating existing pipes or pipelines used to transport gas or liquids</td></tr>
<tr><td></td><td></td><td colspan="2">Relocating existing cables, lines, or wires used to transmit electricity or communications</td></tr>
<tr><td></td><td></td><td colspan="2">Repair, restoration, or replacement of existing pipes, pipelines, cables, lines, wires, and water intakes</td></tr>
<tr><td></td><td></td><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></td><td></td><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>Shoreline modifications</td><td>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></td><td></td><td colspan="2">Installation of soft and/or hybrid shoreline activities</td></tr>
<tr><td>Expand or install a new in-water or overwater structure</td><td>PDC #5</td><td colspan="2">All actions necessary to complete installation of the following:</td></tr>
<tr><td></td><td></td><td>Mooring buoys</td><td>Mooring dolphin/piles</td></tr>
<tr><td></td><td></td><td>Debris booms</td><td>Fender pile(s)</td></tr>
<tr><td></td><td></td><td>Staircases</td><td>Marine rails</td></tr>
<tr><td></td><td></td><td>Noncovered boat lift(s)</td><td>Boat ramps</td></tr>
<tr><td></td><td></td><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)	

Activity Category	Associated Project Design Criteria (PDC) Number	Activities Covered
Habitat enhancement activities	PDC #11	Wetland, shoreline, stream, and floodplain restoration
		In-water or over-water structure, rubble, or derelict vessel removal
Set-back or removal of existing 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 remediation	PDC #14	Dredging, excavation, capping or other methods of removing or isolating contaminated sediments from aquatic habitats

To aid in the consultation process, the Corps provided an estimated number of projects expected annually based on the activity categories. The Corps provided information on the history of activity and projections for future use in Table 2. The totals are based on a two-year average of data between March 19, 2017 – December 31, 2019. In addition, the Corps increased these averages by five percent for purposes of this analysis to allow for increasing projects into the future and to address uncertainty and unforeseen circumstances.

Table 2. Estimated number of Corps permits issued annually by PDC type that could be eligible for coverage through the SSNP Programmatic Consultation proposed action.

PDC	Estimated number of Corps permits which 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
PDC #9	5
PDC #10	9
PDC #11, PDC #12, PDC #13	30
PDC #14	17
Total	320

The activities covered by SSNP incorporate impact reduction, minimization, and conservation measures within GCMs and PDCs as described in the subsections below to 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. The 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. Detailed information on project specific PDCs and GCMs can be found in the subsections below.

4.3 Program Administration

4.3.1 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 Conservation Calculator.

4.3.2 Timeline and Revisions

This programmatic consultation will be effective from the date of issuance of this Opinion. The Corps' regulatory permitting program has no specified end date. To evaluate the effects of the action for this SSNP consultation framework, the USFWS assumed an annual average number of permits for various types of activities (Table 2) and assumed a 20-year period of permits issued for these activities (see Table 7). This 20-year implementation assumption is based on the USFWS' conservative estimate of the period of time in which we can reasonably evaluate the effects of program implementation on bull trout, designated bull trout critical habitat, and marbled murrelet given current information about climate change and resulting impacts on habitat factors (including prey resource availability) for these species. The USFWS thus analyzes the effects of the short-term impacts (i.e., construction impacts) and long-term impacts (authorized structures lasting in the marine environment for 40 to 50 years) of 20 years of permits issued for activities under the SSNP framework. The USFWS anticipates that new information about the proposed action, including but not limited to changes to project design criteria, and type and location of conservation offsets, as well as regional climate adaptation strategies, are highly likely to emerge during this period. Thus, while there is no specific duration of the proposed action, and no express term for this Opinion, USFWS anticipates that in order to continue utilizing this programmatic consultation framework to issue new permits after 20 years from the effective date of this Opinion, reinitiation will be required. The Agencies will discuss any revisions or need for re-initiation during their Annual Coordination meeting and therefore re-initiation could occur prior to the end of 20-year period of implementation assumed in our Opinion.

4.3.3 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 to cover 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 in an individual or single 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 in the Incidental Take Statement of the USFWS and NMFS SSNP programmatic Opinions.

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 SSNP programmatic.

F. The proposed work includes sufficient conservation offsets, where applicable, to address impacts to the Salish Sea nearshore environment on ESA listed species and designated critical habitat.

4.3.4 Electronic Submission

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

A. USFWS Submission:

1. Submit information to SSNP_WA@fws.gov
2. Email Subject Line: SSNP Notification Only (PDC #) OR SSNP Notification and Minor Alteration Request (PDC #/GCM #).
3. Within 5 days of receipt, the USFWS will provide the Corps an email stating the notification/request has been received. If the Corps has not received this email within 5 days, the Corps will seek to confirm whether USFWS has received the submitted materials.
4. Following confirmation of receipt of materials from USFWS, if the Corps does not receive a response within 30 days, the Corps has met its obligations under Section 7 for USFWS and can proceed with a permit decision.

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)

4.3.5 NMFS Review and Verification (Not applicable to USFWS Review and Notification)

Note: The USFWS does not require additional review and verification of the above projects as long as all necessary minimization measures and conservation measures within the descriptions of the General Construction Measures and the Project Design Criteria are met. The USFWS expects these provide all needed measures to minimize effects to listed species under the jurisdiction of USFWS. However, if NMFS, through their verification process, determines a proposed action does not fall within SSNP, the Corps will provide this information to the USFWS and either request USFWS conduct a review to determine if the action falls within SSNP for USFWS species or request individual consultation.

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 to NMFS. 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 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 for species under NMFS jurisdiction.

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

4.3.6 Minor Alterations from Proposed Measures

The Services 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 consultation. The USFWS and NMFS will verify whether or not the resulting effects are consistent with this programmatic consultation. 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.

E. Underwater sound attenuation methods demonstrating equivalent sound attenuation to bubble curtains.

4.3.7 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 the NMFS or USFWS 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; 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.

4.3.8 Conservation Offsets (i.e., Conservation Measures)

Conservation Measures are "…*actions to benefit or promote the recovery of listed species that are included by the Federal agency as an integral part of the proposed action. These actions will be taken by the Federal agency or applicant, and serve to minimize or compensate for, project effects on the species under review* …" (USFWS and NMFS 1998). For the purposes of this programmatic consultation, in order to be consistent with agreed-upon language between the Corps, NMFS, and the USFWS, these are referred to as "Conservation Offsets" in the remainder of this Biological Opinion.

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. This programmatic consultation is intended to ensure that the loss of habitat functions and values, resulting from individual projects, does not meaningfully aggregate over space and time.[5] 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 designated critical habitat. Compensatory mitigation required under Section 404 of the CWA can serve as conservation offsets if consistent with the criteria established in this programmatic consultation. One way project applicants can ensure their proposed project does not result in a long-term loss of habitat function is to provide conservation offsets as calculated utilizing NMFS' Puget Sound Nearshore Calculator[6] (Conservation Calculator)[7] for certain activity types (Appendix A).

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[5] 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 permanent loss of habitat function and value.

[6] 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 an accurate equivalency between habitat impacts of the proposed project and conservation offsets offered to compensate for those habitat impacts. The USFWS and NMFS will evaluate any proposed alternative and determine if it meets these criteria, thereby ensuring no net loss of long-term habitat function.

[7] The most current version of the Conservation Calculator is found at: https://www.fisheries.noaa.gov/resource/tool-app/puget-sound-nearshore-conservation-calculator. The NMFS and USFWS will jointly update the Conservation Calculator and anticipate that adjustments made to the Conservation Calculator will not change the overall application or intent to provide equivalent or greater habitat function replacement.

A. Conservation offsets are needed for the following activity categories:

    1. PDC #2 Utilities. New footings for relocated transmission lines
    2. PDC #4 Shoreline modification
    3. PDC #5 Expand or install a new in-water or overwater structure
    4. PDC #6 Repair or replace an existing structure
    5. PDC #9 Dredging for vessel access

B. Enduring adverse effects on nearshore habitat 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:

    1. **Option 1**. Design project to avoid and minimize adverse effects under the ESA by incorporating and documenting, with your 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).

        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.

    2. **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 applicant has ownership or secured permission and a conservation easement, if necessary. Applicant-responsible within-basin habitat improvements need 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.

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:

    i. 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);

    ii. Where the improvements would occur;

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

    iv. When the improvements would occur.

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[8] May require a conservation easement.

   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.[9]

   c. For planting related activities, submit a planting and monitoring plan with your consultation initiation package.

   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.

3. **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[10] restoration project that will improve nearshore or estuarine habitat.

For applicants choosing Option 3 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:

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

      ii. Where the improvements would occur;

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

      iv. When the improvements would occur.

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

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[9] If proposing structure removals with site protections following Corps regulations, please refer to 33 CFR 332.4(c) and 33 CFR 332.7(a), and the following website describing deed restrictions: https://www.nws.usace.army.mil/Portals/27/docs/regulatory/Forms/DeedRestrictionHandout.pdf?ver=2016-06-06-150203-510.

[10] See Puget Sound Partnership Nearshore Credit Program Service Areas for representation of nearshore/marine basins: https://www.psp.wa.gov/pspnc.php

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

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

4. **Option 4**. Purchase conservation credits from a USFWS approved conservation bank, in-lieu fee program, and/or crediting provider.[11]

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 applicant that identifies the number of credits/offsets the applicant 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 USFWS prior to the impacting project's construction start date.

4.3.9 Marine Mammals
(does not address USFWS trust resources)

In-water construction activities causing underwater noise greater than 120dBrms, such as pile driving, jackhammering, and underwater sawing, will shut down if marine mammals enter the zone of influence.[12] Construction activities will not resume until all marine mammals have been cleared from the zone of harm and are observed to be moving away from the construction site.

A. If Southern Resident Killer whales 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.

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[11] For example, the Puget Sound Partnership, a state agency, has coordinated with the Services to provide habitat projects utilizing the Conservation Calculator. Per the Memorandum of Understanding between NMFS, USFWS, and PSP, conservation credit projects would be implemented within six years of credit purchase.

[12] During vibratory pile driving, the zone of influence extends to the 120dB isopleth and extends to the 160dB isopleth during impact pile driving.

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

4.3.10 Monitoring and Reporting

The applicant must provide the following information to the Corps, NMFS and USFWS 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 SSNP_WA@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:

1. For multiple year vessel access and functionality maintenance dredging actions, the applicant 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.

2. Annual Post-dredging Reports will include:

   a. Method of dredging and equipment used in dredging operation

   b. Amount of material removed during dredging

   c. Actual footprint of dredging

   d. Dates on which dredging occurred and time at which dredging occurred

   e. Location of disposal of dredged materials

D. Conservation Offset Documentation:

    1. Applicants acquiring offsets under Program Administration #8, conservation offsets option 2, must submit to the Corps and NMFS, written confirmation that they implemented their verified habitat improvement plan within three years and 60 days from the impacting project's construction start date.

E. Annual Program Report. The Corps will submit an Annual Report to the NMFS at ssnp-wa.wcr@noaa.gov and USFWS at SSNP_WA@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.

F. 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.

4.3.11 General Construction Measures

Projects intending to utilize the SSNP programmatic must comply with the following General Construction Measures (GCMs) as applicable.

1. Minimize Construction Impacts at Project Site

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 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 and USFWS 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 percent 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 USFWS.

D. To assist a permittee in determining biological monitoring needs during pile installation, an optional Pile Installation Calculator is available.[13] The tool aids in determining the extent of underwater noise impacts and distances. Construction activities will cease if marbled murrelets are observed within or entering a zone where pile driving noise is likely to cause injury.

E. No more than 8 piles may be driven on any day using impact pile driving.

F. Impact pile driving will not begin earlier than two hours after sunrise and will be complete at least one hour before sunset for the period from Apri1 1 thru September 30.

G. Complete all work waterward of the line of the HAT during dates listed in the most recent version of in-water work guidelines, WDFW Marine Water Work Windows: https://app.leg.wa.gov/WAC/default.aspx?cite=220-660-330

H. Hydraulic and bathymetric measurement, sediment sampling and geotechnical sampling are not constrained by the work timing constraints in (G) above and may be completed at any time.

7. Marbled Murrelet Monitoring Plan

The applicant 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 (i.e., more than two piles greater than 12 inches driven per day).

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[13] The USFWS "Acoustic Effects Calculator" can be found at https://www.fws.gov/library/collections/washington-section-7-consultation-technical-assistance-and-guidance or through contacting USFWS with questions on the calculator or how to access (WA_SSNP@fws.gov).

A. Applicants 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 (Appendix B). A plan must be submitted with the project notification.

B. Certified observers will visually monitor the monitoring area (area of potential injury) for marbled murrelets following the protocol (provide citation for our protocol).

C. An appropriate number of certified marbled murrelet observers will be positioned to provide adequate coverage of the monitoring area without looking farther than 50 meters to ensure no marbled 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 marbled murrelets are detected in the monitoring area or when visibility impairs monitoring.

F. If marbled murrelets are spotted in the monitoring area, pile driving will not resume until the marbled murrelets have left the monitoring area and at least 2 full sweeps of the monitoring area have confirmed no marbled 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.

H. The applicant will provide a summary of marbled murrelet monitoring results, including observation dates, times, and conditions; description of any potential "take" identified by the biologist, and seabirds found during beach surveys to USFWS.

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 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 one-tenth 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:

   1. 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.

   2. 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).

   3. Polyurea barriers must be installed on dry piles that are free of loose wood, splinters, sawdust or mechanical damage.

   4. 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.

   5. 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.

   6. 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 field 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 (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, those new or replaced impervious surfaces 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:

    1. Removing marine debris or marine life from existing outfalls.
    2. Replacing outfall flap gates or flow control devices.
    3. Minor repairs or non-structural pavement preservation including such as installation or repair of guard rails, patching, chip seal, grind/inlay, overlay; removal or plugging of scuppers in a way that benefits stormwater treatment.
    4. Modifying on-street parking modifications that reduces contributing impervious surfaces.
    5. Retrofitting, without increasing the amount of pollution generating impervious surface, an existing impervious surface (pavement, parking lot, etc.) as necessary and required by law to comply with Americans with Disabilities Act of 1990 (ADA) standards for accessible design (e.g., curb cuts). This does not include retrofitting of overwater structures.
    6. Minor building repairs such as re-roofing, re-siding, painting, replacing or installing fasteners, shingles, flashing, and gutters, or similar building elements.[14]

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.[15.]

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

[15] See e.g., Fassman and Blackbourn 2010, Drake et al., 2014; Alizadehtazi et al. 2016 re feasibility of pervious materials; see Himnam 2005, Hinman 2013, and Skaloud 2016 re LID stormwater management.

C. For commercial, industrial, or public application, utilize LID[16] 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:

   1. Minimize impervious area.
   2. Limit disturbance.[17]
   3. Landscape and hardscape areas.[18]

D. Provide a Post-Construction Stormwater Management Plan (PCSMP) for any action proposed to be carried out consistent with this GCM to NMFS. This plan will be validated by NMFS during the verification step described in Section 4.3.5 (Program Administration – NMFS Review and Verification). A PCSMP must include the following information:

   1. 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.
   2. Site maps indicating the following elements within the project boundaries:
      a. Property boundaries and project boundaries, especially if the project includes activities extending beyond/outside the property or parcel boundaries.

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[16] 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.

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

[18] Examples include: restored soils, tree planting, de-pave existing pavement (such that it becomes 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.

b. Impervious areas, landscape areas, and undeveloped natural areas (e.g., forested areas, wetlands, riparian zones).

c. Location and extent of all LID stormwater facilities and Best Management Practices (BMPs) by type and capacity.

d. Location and extent of proprietary stormwater treatment technologies[19] by type and capacity, if proposed.

e. 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).

f. 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[20][21] and provide adequate treatment for runoff that will be discharged from the site,[22] based on design storm flows.[23] the Water Quality Treatment Analysis should include:

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[19] 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.

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

[21] 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.

[22] 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.

[23] 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.

1. 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).

2. 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.

3. 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[24] stormwater runoff for all storm events between the 50 percent of the 2-year, 24-hour and the 10-year storm events.

1. Describe each proposed LID facility's capacity in terms of flow or volume retention/detention depending on facility type.

2. Describe each proprietary stormwater facility's capacity in terms of flow or volume retention/detention depending on facility type.

3. 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[25] 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:

1. Peak runoff exceeds 0.5 cfs during the 2-year, 24-hour storm event; and,

2. Not meet the flow control requirements, detailed above; and,

3. Discharge into an intermittent or perennial water body with a watershed area less than 100 square miles above the discharge location.

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[24] 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.

[25] 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.

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:

    1. Lower discharge endpoint, by U.S. Geological Survey flood frequency zone = 50 percent of 2-year event (i.e., Water Quality Design Storm)

    2. Upper discharge endpoint

        a. Entrenchment ratio[26] <2.2 = 10-year event, 24-hour storm; or,

        b. 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:

    1. Maintain natural drainage patterns such that runoff is not redirected to a different drainage basin (i.e., watershed, subwatershed) from the pre-project conditions.

    2. 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.

    3. 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.[27]

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 4.3.5. 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.

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

[27] 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.

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:

    1. Complete earthwork in wetlands, riparian areas, and stream channels as quickly as possible.

    2. Cease project operations when high flows may inundate the project area, except for efforts to avoid or minimize resource damage.

    3. If eroded sediment appears likely to be deposited in the stream during construction, install additional sediment barriers as necessary.

    4. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.

    5. 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.

    6. Inspect and monitor pollution and erosion control measures throughout the length of the project.

    7. Remove sediment from erosion controls if it reaches one-third of the exposed height of the control.

    8. Whenever surface water is present, maintain a supply of sediment control materials and an oil-absorbing floating boom at the project site.

    9. 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.

   1. Do not electrofish when the water appears turbid, e.g., when objects are not visible at depth of 12 inches.

   2. Do not intentionally contact fish with the anode.

   3. Follow NMFS (2000[28] 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 machine settings, water temperature and conductivity, and adjust or postpone procedures as necessary to reduce injuries.

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

f. If buckets are used to transport fish:

   i. Minimize the time fish are in a transport bucket. Check condition of fish in the bucket frequently.

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

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

   iv. Use aerators or replace the water in the buckets at least every 15 minutes with cold clear water.

   v. 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.

   vi. 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

5 PROJECT DESIGN CRITERIA FOR COVERED ACTIVITIES

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

5.1 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 2011) or subsequent version and should follow "Water Crossing Designs Guidelines "Appendix D: Tidally Influenced Crossings" (Bernard 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:

   1. 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.

2. 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 (Bernard et al. 2013) may be used.

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

3. 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.

        i. The lateral delineation of the scour prism is defined by the criteria span.

        ii. 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).

4. 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 percent and 50 percent 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 applicant must provide justification to the Corps project manager and Services on why embedment cannot occur at the project site and verify that the proposed design meets fish passage requirements with a NMFS engineer.

5. 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 PDC's (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 2011 or most recent criteria.

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

1. 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,

    b. the functional floodplain,

    c. any artificial fill within the project area,

    d. the existing crossing to be replaced, and

    e. the proposed crossing.

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

5.2 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:

   1. Relocating pipes or pipelines used to transport gas or liquids.

   2. Relocating cables, lines, or wires used to transmit electricity or communications.

   3. Repair or replacement of pipes, pipelines, cables, lines, wires, and water intakes.

   4. 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.

   5. Overhead utility line actions involving long-term vegetation removal, excavation, grading, and installation of footings, foundations, or other structures in riparian and floodplain habitats.

   6. 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:

   1. Have all necessary equipment and supplies on-site to contain an unintended release of drilling mud.

    2. 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.

    3. On-site visual monitoring by a knowledgeable HDD inspector must occur during construction operations and of the construction area.

    4. 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.

    5. 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:

    1. Geotechnical information including soil type, elevation, and depth of the HDD;

    2. A containment, response, and notification plan

    3. Clean-up measures

    4. Restoration and post-construction monitoring plan

5.3 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.

5.4 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:

    1. the repair, replacement, and/or installation of new rock, concrete, untreated wood, and steel sheet pile bulkheads,

    2. 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:

1. 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.

2. Prior to high tide, block nets will be set to prevent fish from accessing the area behind the new sheet pile installation.

3. A barge or land-based equipment will be used to deliver materials and barge grounding must be avoided at any time.

4. Bulkhead removals must include submittal and implementation of a riparian vegetation planting plan (RVPP)[29] where riparian vegetation or areas where riparian vegetation naturally would occur or will be disturbed. The RVPP must be submitted to NMFS and the Corps as part of the SSNP ESA application materials.

5. The installation of new armoring must follow Integrated Streambank Protection Guidelines (Cramer et al. 2002)

6. Fill all beach depressions created during construction prior to the next inundating tide

C. Soft Shoreline Treatments Design Criteria

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.

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[29] 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)

7. Biodegradable fabric and support filters may be used but must be designed and constructed to prevent surface exposure of the material through time.

D. Hybrid Shoreline Treatments Design Criteria

   1. 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.

   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 percent 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 and must be covered with sand/small gravel mixes in such a way to minimize net erosion through time.

   5. 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.

   6. Incorporate beach nourishment (sand and small gravel) as needed to minimize lowering of beach grade and net erosion.

5.5 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 SAV surveys to determine presence or absence and the applicant 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:

   1. New mooring buoys

   2. Mooring dolphin/piles

   3. Debris booms

   4. Fender pile(s)

   5. Staircases
   6. Marine rails
   7. Boat lift(s) (non covered),
   8. 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.
   9. 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:

   1. Unless the applicant 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 ADA.
   2. 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).
   3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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).

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

10. 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.

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

12. 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.

13. 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.

14. A new staircase must be constructed as follows:
    a. Stairway landings and steps must be entirely grated with either multi-directional grating with 40 percent open space or square grating with 60 percent open space.
15. 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.

5.6 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:
    1. aids to navigation,
    2. house boats,
    3. boat houses, covered boat houses, boat garages,
    4. boat ramps (commercial, public, or private),
    5. breakwaters,
    6. buoys and mooring structures
    7. commercial, industrial, and residential piers or
    8. wharfs, port, industrial, and marina facilities
    9. piers, ramps, and floats,
    10. dolphins,
    11. float plane hangars,
    12. floating storage units,
    13. floating walkways,
    14. debris booms,
    15. groins, jetties.

B. Design criteria for these structures include:

   1. Boat ramps should be elevated in sediment transport zones, to the maximum extent practicable

   2. 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.

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

   4. Refer to GCM #11 for the removal of treated wood other than piles.

   5. Decking replacement on residential or community pier and ramps over 33 percent or over 250 square feet must be entirely grated with 60 percent open area (compliant with WAC 220-660-390).

   6. 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 applicant demonstrates that modifications are necessary to comply with other laws or regulations, e.g., the accessibility guidelines from the ABA or the ADA.

   7. All float pilings and mooring buoys must be fitted with devices to prevent perching by piscivorous birds.

   8. Any existing structure that is relocated in a marina must remain within the existing overall marina footprint.

   9. 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.

5.7 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:

1. Pile resets
2. Capping of piles
3. Replacement of rubber strips (but no tires)
4. Replacement of float stops
5. Encapsulation of flotation material
6. Height extension of existing pilings
7. Replacement of fender piles that do not contribute to the structural integrity of the structure.
8. Replacing well-functioning solid decking with grated decking.[30] Replacement grating must have a minimum of 50 percent grating and all grating must have a minimum of 60 percent open space, unless the applicant demonstrates that modifications are necessary to meet a public purpose and need, e.g., to comply with accessibility guidelines from the ABA or the ADA.

5.8 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.

5.9 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-

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

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 applicant will describe how the applicant 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 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:

    1. Use an environmental bucket or covered bucket, where practicable.
    2. Lower the bucket slowly through the water column.
    3. Close the bucket as slowly as possible on the bottom. Do not overfill the bucket.
    4. Hoist the load very slowly.
    5. If dewatering is permissible, pause the bucket at the water surface to minimize distance of discharge.
    6. Ensure that all material is dumped into the barge from the bucket before returning for another bite.
    7. 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:

   1. Placement activities at designated Dredged Material Management Program[31] 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.

   2. The disposal vessel will remain within the boundaries of the disposal site during a disposal event.

   3. 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.

   4. 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, U.S. Environmental Protection Agency, Washington State Department of Ecology and other agencies, as applicable.

   5. 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 applicant is responsible for permitting any beneficial use upland placement, if proposed.

   6. Upland disposal sites will have dikes or other facilities to manage any return water. Return water will meet state water quality standards.

5.10 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 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 applicant shall provide a plan to demonstrate how the action will

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

avoid and minimize impacts. NMFS review and verification is required per Section 4.3.5 (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:

    1. 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.

    2. The dredging must not alter the originally designed character, scope, size, or location of the project area.

    3. 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).

5.11 Habitat Enhancement Activities

The purpose of the following categories is to enhance nearshore habitat for ESA listed species and their designated critical habitat. This PDC does not require conservation offsets. Habitat Enhancement Activities could be standalone projects or could be undertaken as a conservation offset for other activities that reduce the quality of nearshore habitat.

A. Wetland, shoreline, 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:

    1. Enhancement or restoration of wetland, shoreline or floodplain functions and values.

    2. Re-establishment of historic floodplain extent through removal of fill from within the historic 100-year floodplain.

    3. 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.

1. For pile removal, refer to GCM #9 or #10.
2. 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 PM, USFWS and NMFS from the applicant.

5.12 Set-back or removal of existing 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.

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 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.

5.13 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.

Conservation offsets are not needed for this category. 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[32] 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.

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, up to 25 cubic yards of suitable material may be placed to create or improve fish habitat and nearshore environment as follows:

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[32] 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

1. Only clean, suitable material may be placed.

2. 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.

3. When placing material in areas known to have forage fish spawning, applicant will adhere to WDFW timing windows protective of forage fish.

4. When placing material on known surf smelt spawning beaches a spawning survey will be conducted prior to placing material.

5. 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.

5.14 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:

1. Include BMPs to limit re-suspension of contaminants/ contaminated sediments during dredging activities.

2. Include best available BMPs to preclude contaminated groundwater from interfacing with a receiving water supporting ESA-listed species or habitat.

3. 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.

6 ACTION AREA

The action area is defined as 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). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment. The action area includes all tidal areas (i.e., marine or estuary) and adjacent non-tidal areas (i.e., upland, riparian, wetland) where stressors caused by the proposed action, including both covered activity categories and any conservation offsets that may also be implemented, could occur. Covered activities and associated stressors extend into estuaries and rivers up to the highest point of saltwater influence, including all riparian areas, shoreline, and all waters, shallow and deep, of the Puget Sound, Strait of Juan de Fuca, and the San Juan Islands.

Most stressors are concentrated in the vicinity of each structure (pier/ramp/float, marine rail, staircase, watercraft lift, or buoy), and/or extent of elevated underwater sound pressure levels (SPLs) or elevated terrestrial sound from impact pile driving. The effects of elevated underwater sound are encompassed within further reaching effects described below. The extent of elevated in-air sound was determined based on the installation of no more than two 36-inch steel piles (105dBA$_{\mathrm{Lmax}}$ measured at 50 feet) at any one project site. Due to the variation in habitat across the Salish Sea, presence of vessel traffic and other factors, an ambient in-air sound level of 60dBA$_{\mathrm{Leq}}$ was used. The USFWS conservatively anticipates that elevated in-air sound will be indistinguishable over background conditions within 8,900 feet in any location. Project sound will drop below ambient sound levels over shorter distances in areas with trees and urban areas.

While other in-water stressors (e.g., increases in boat traffic) may extend beyond the immediate vicinity of individual construction projects and conservation offsets, the extent of these stressors will be encompassed within the extent of the furthest-reaching stressors of underwater sound and in-air sound.

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 ports, 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 ongoing future vessel operation. Intermittent impacts from these vessels would include elevated underwater and in-air sound, 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, sight-seeing, and wildlife watching, emergency use, and recreational use, we expect the vessel use to be evenly distributed through the Salish Sea. In addition, the distribution of vessel use outside of the Salish Sea (i.e., west of the Strait of Juan de Fuca) will be indistinguishable from vessels originating from areas outside of the Salish Sea (i.e., Grays Harbor, Willapa Bay, or areas in Canada).

Therefore, considering all areas affected by the proposed action, we define the action area for this programmatic action as all marine influenced areas of the Strait of Juan de Fuca, North Puget Sound/San Juan Islands, Hood Canal, and South Puget Sound and adjacent upland areas within 8,900 feet from the shoreline. In this document, we refer to this area as the Salish Sea (Figure 1).

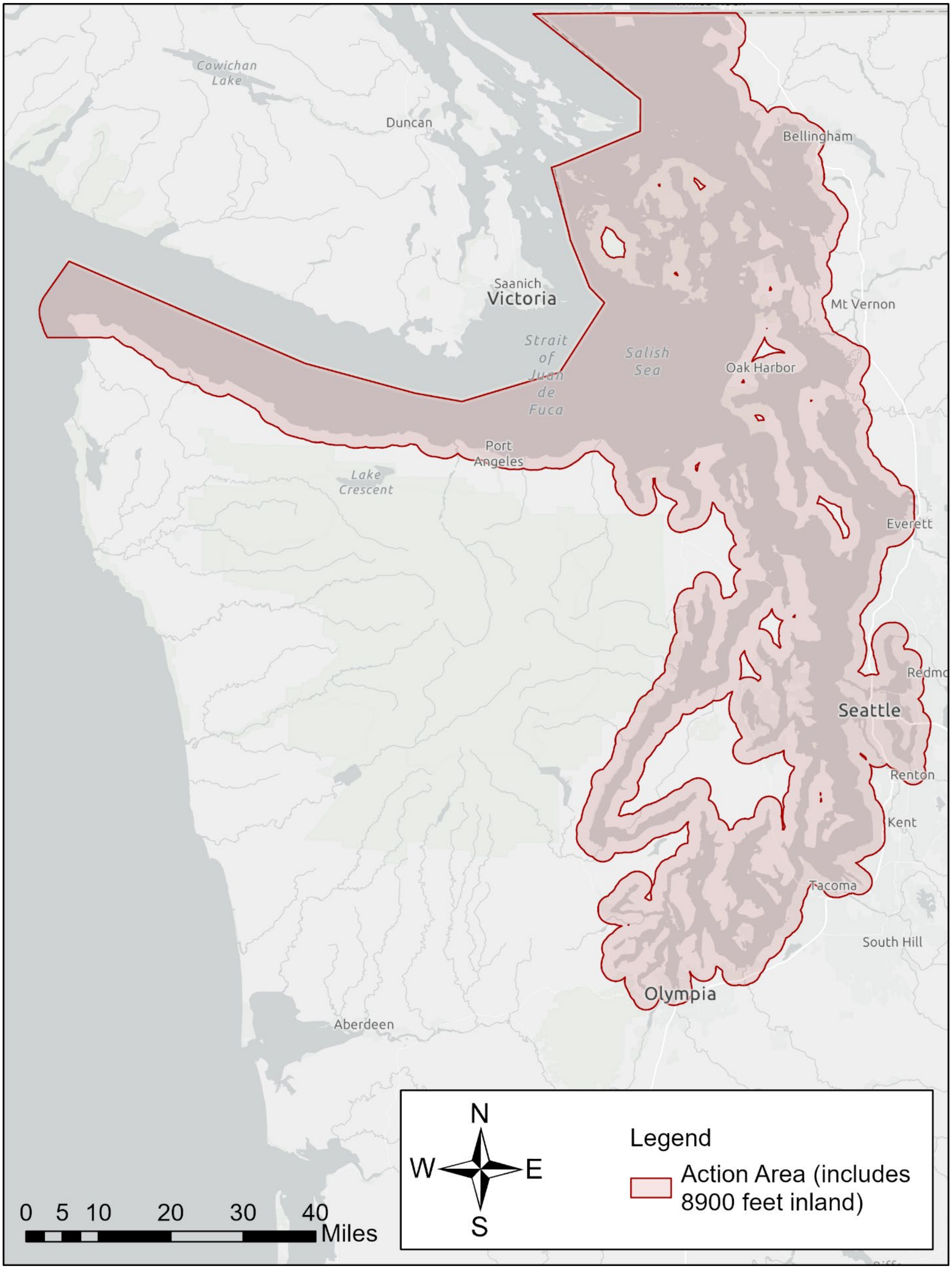


Figure 1. Action Area for the Salish Sea Nearshore Programmatic

7 ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

7.1 Jeopardy Determination

In accordance with policy and regulation, the jeopardy determination in this Biological Opinion relies on the following components:

> The *Status of the Species*, which evaluates the species' current range-wide condition relative to its reproduction, numbers, and distribution; the factors responsible for that condition, its survival and recovery needs; and explains if the species' current range-wide population retains sufficient abundance, distribution, and diversity to persist and retrains the potential for recovery (USFWS and NMFS, 1998).
>
> The *Environmental Baseline*, which includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).
>
> The Environmental Baseline section of this biological opinion evaluates the past and current condition of the species and its habitat, including its designated critical habitat, in the action area relative to its reproduction, numbers, and distribution absent the effects of the proposed action; including the anticipated condition of the species contemporaneous to the term of the action; the factors responsible for that condition; and the relationship of the action area to the survival and recovery of the species.
>
> The *Effects of the Action*, which refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR §402.02).
>
> The Effects of the Action section of this biological opinion evaluates all direct and indirect effects to the species and its habitat that are reasonably certain to be caused by the proposed action in the action area (i.e., the effects would not occur but for the proposed action and are reasonably certain to occur) and how those impacts are likely to influence the survival and recovery of the species.
>
> *Cumulative Effects*, which 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 (§402.02).

> The Cumulative Effects section of this biological opinion evaluates the effects of future State or private activities reasonably certain to occur in the action area on the species and its habitat, and how those impacts are likely to influence the survival and recovery of the species.

In accordance with policy and regulation, the jeopardy determination is made by formulating the Service's opinion as to whether the proposed action, taken together with cumulative effects, reasonably would be expected to reduce appreciably the likelihood of both the survival and recovery of the species in the wild by reducing the reproduction, numbers, or distribution of that species. "To reduce appreciably" is not merely discernible, but consequential at the species level (see 83 FR 35178, July 25, 2018).

7.2 Adverse Modification Determination

In accordance with policy and regulation, the adverse modification determination in this Biological Opinion relies on the following definitions and components:

> *Destruction or adverse modification* means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR 402/02).
>
> The *Status of Critical Habitat*, which describes the range-wide condition of the CH in terms of essential habitat features, primary constituent elements, or physical and biological features that provide for the conservation of the listed species, the factors responsible for that condition, and the intended value of the CH for the conservation of the listed species.
>
> The *Environmental Baseline*, describes the past and current condition of CH in the action area absent the effects to the species and its CH caused by the proposed action; including the anticipated condition of the species and its CH contemporaneous to the term of the action, the factors responsible for that condition, and the conservation value of CH in the action area for the conservation of the listed species.
>
> The *Effects of the Action*, evaluates all direct and indirect effects to CH that are reasonably certain to be caused by the proposed action (i.e., the effects would not occur but for the proposed action and are reasonably certain to occur), including the effects of other activities that are caused by the proposed action, and how those impacts are likely to influence the conservation value of the affected CH.
>
> *Cumulative Effects*, which evaluates the effects to the CH of future non-Federal (State or private) activities that are reasonably certain to occur in the action area and how those impacts are likely to influence the conservation value of the affected CH.

For purposes of making the adverse modification determination, the USFWS evaluates if the effects of the proposed Federal action, taken together with cumulative effects, are likely to impair or preclude the capacity of CH to serve its intended conservation function for the conservation of the listed species. The key to making this finding is clearly establishing the role of CH in the action area relative to the value of CH, and how the effects of the proposed action, taken together with cumulative effects, are likely to alter that role.

8 STATUS OF THE SPECIES RANGE-WIDE

8.1 Bull Trout

Bull trout was listed as a threatened species in the coterminous U.S. in 1999. Throughout its range, bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, incidental angler harvest, entrainment, and introduced non-native species (64 FR 58910 [Nov. 1, 1999]). Since the listing of bull trout, there has been very little change in the general distribution of bull trout in the coterminous U.S., and we are not aware that any known, occupied bull trout Core Areas have been extirpated (USFWS 2015a). However, many of the Core Areas have observed declines, while a few have maintained or substantially increased their populations.

The 2015 Recovery Plan for bull trout identifies six Recovery Units within the listed range of the species (USFWS 2015a). Each of the Recovery Units are further organized into multiple bull trout Core Areas, which are mapped as non-overlapping watershed-based polygons, and each Core Area includes one or more local populations. Within the coterminous U.S., we currently recognize 109 occupied Core Areas, which comprise 600 or more local populations of bull trout (USFWS 2015a). Core Areas are functionally similar to bull trout metapopulations, in that bull trout within a Core Area are much more likely to interact, both spatially and temporally, than are bull trout from separate Core Areas.

The USFWS has also identified a number of marine or mainstem riverine habitat areas outside of bull trout Core Areas that provide foraging, migratory, and overwintering habitat that may be shared by bull trout originating from multiple Core Areas. These shared foraging, migratory, and overwintering (FMO) areas support the viability of bull trout populations by contributing to successful overwintering survival and dispersal among Core Areas (USFWS 2015a).

For a detailed reference account of bull trout biology, life history, threats, demography, and conservation needs, refer to Appendix C: Status of the Species - Bull Trout.

8.2 Marbled Murrelet

The marbled murrelet was listed as a threatened species in Washington, Oregon, and California in 1992 under the federal ESA. The primary reasons for listing included extensive loss and fragmentation of old-growth forests which serve as nesting habitat for marbled murrelets and human-induced mortality in the marine environment from gillnets and oil spills (57 FR 45328

[Oct. 1, 1992]). Although some threats such as gillnet mortality and loss of nesting habitat on Federal lands have been reduced since the 1992 listing, the primary threats to species persistence continue (USFWS 2019b, p. 65).

The most recent population estimate for the entire Northwest Forest Plan area in 2019 was 21,200 marbled murrelets (95 percent confidence interval [CI]: 16,400 to 26,000 birds) (McIver et. al 2021, p. 3). The long-term trend derived from marine surveys for the period from 2001 to 2018 indicate that the marbled murrelet population across the entire Northwest Forest Plan area has increased at a rate of 0.5 percent per year (McIver et. al 2021, p. 4). While the overall trend estimate across this time period is slightly positive, the confidence interval is fairly tight around zero (95 percent CI -0.5 to 1.5 percent), leading to the conclusion that there is no directional trend (McIver et. al 2021, p. 4).

Murrelet population size and marine distribution during the summer breeding season is strongly correlated with the amount and pattern (large contiguous patches) of suitable nesting habitat in adjacent terrestrial landscapes (Falxa and Raphael 2016, p. 109). The loss of nesting habitat was a major cause of marbled murrelet decline over the past century and may still be contributing as nesting habitat continues to be lost to fires, logging, and windstorms (Miller et al. 2012, p. 778). Monitoring of marbled murrelet nesting habitat within the Northwest Forest Plan area indicates nesting habitat has declined from an estimated 2.53 million acres in 1993 to an estimated 2.23 million acres in 2012, a total decline of about 12.1 percent (Falxa and Raphael 2016, p. 72). The largest and most stable marbled murrelet subpopulations now occur off the Oregon and northern California coasts, while subpopulations in Washington declined at a rate of approximately -3.9 percent per year for the period from 2001 to 2019 (McIver et al. 2021, p. 4). Rates of nesting habitat loss have also been highest in Washington, primarily due to timber harvest on non-Federal lands (Falxa and Raphael 2016, p. 37), which suggests that the loss of nesting habitat continues to be an important limiting factor for the recovery of marbled murrelets.

Factors affecting marbled murrelet fitness and survival in the marine environment include: reductions in the quality and abundance of marbled murrelet forage fish species, harmful algal blooms, toxic contaminants; marbled murrelet by-catch in gillnet fisheries; marbled murrelet entanglement in derelict fishing gear; oil spills, and human disturbance in marine foraging areas (USFWS 2019b, pp. 29-61). While these factors are recognized as stressors to marbled murrelets in the marine environment, the extent that these stressors affect marbled murrelet populations is unknown. As with nesting habitat loss, marine habitat degradation is most prevalent in the Puget Sound area where anthropogenic activities (e.g., shipping lanes, boat traffic, and shoreline development) are an important factor influencing the distribution and abundance of marbled murrelets in nearshore marine waters (Falxa and Raphael 2016, p. 106).

Detailed accounts of marbled murrelet biology, life history, threats, demography, and conservation needs are presented in the Recovery Plan for the Marbled Murrelet (USFWS 1997), and in the Northwest Forest Plan—The first 20 years (1994-2013): Status and Trend of Marbled Murrelet Populations and Nesting Habitat (Falxa and Raphael 2016) as well as Appendix E in this Opinion. Status and Trend of Marbled Murrelet Populations in the Northwest Plan Area, 2000 to 2018 (McIver et al., 2021) is available at: https://www.fs.fed.us/r6/reo/monitoring/marbled-murrelet.php.

9 STATUS OF DESIGNATED CRITICAL HABITAT

9.1 Bull Trout

On October 18, 2010, the USFWS issued a final revised critical habitat designation for the bull trout (70 FR 63898). The critical habitat designation includes 32 Critical Habitat Unit (CHUs) in six proposed Recovery Units located throughout the coterminous range of the bull trout in Washington, Oregon, Idaho, Montana, and Nevada. The species' final recovery plan (USFWS 2015a) formally designated these Recovery Units. Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) FMO habitat. The conservation role of bull trout critical habitat is to support viable Core Area populations (75 FR 63943). CHUs generally encompass one or more Core Areas and may include FMO areas, outside of Core Areas, that are important to the survival and recovery of bull trout.

The final rule excludes some critical habitat segments. Critical habitat does not include: 1) waters adjacent to non-federal lands covered by legally operative incidental take permits for Habitat Conservation Plans (HCPs) issued under the ESA in which bull trout is a covered species on or before the publication of this final rule; 2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated inclusion would impair their relationship with the USFWS; or, 3) waters where impacts to national security have been identified (75 FR 63898).

Bull trout have more specific habitat requirements than most other salmonids (USFWS 2010a, b). The predominant habitat components influencing their distribution and abundance include water temperature, cover, channel form and stability, spawning and rearing substrate conditions, and migratory corridors. The PCE or Primary Biological Factors (PBFs) of bull trout critical habitat, as revised in 2010, are (USFWS 2010a, b):

> Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia;
> Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers;
> An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish;
>
> Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure;
>
> Water temperatures ranging from 2 °C to 15 °C (36 °F to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence;

> In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system;
>
> A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph;
>
> Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited; and,
>
> Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout, *Salvelinus fontinalis*); or competing (e.g., brown trout, *Salmo trutta*) species that, if present, are adequately temporally and spatially isolated from bull trout.

For a detailed reference account of the status of designated bull trout critical habitat, refer to Appendix D: Status of Designated Critical Habitat - Bull Trout.

10 ENVIRONMENTAL BASELINE

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

Conditions of the environmental baseline for both bull trout and marbled murrelet reflect a broader pattern of land use and development in the nearshore, along the shorelines, and in the estuaries of watersheds that drain to the action area. This pattern of land use and development affects the availability and quality of forage resources. 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 (NMFS 2021 p. 97). The upper extent of the nearshore covers the terrestrial upland that contributes sediment, shade, organic material like leaf litter, and invertebrates. 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 p.5). 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 including marbled murrelet and bull trout directly through available habitat and indirectly through forage diversity and quality.

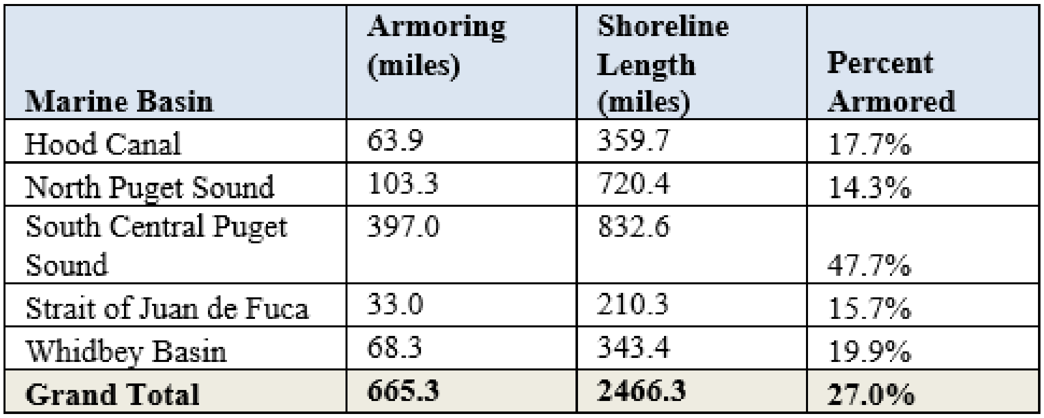
Overall, the baseline condition of the Puget Sound and the Salish Sea nearshore is degraded with reduced water quality; decreased forage and prey availability and diversity; altered nearshore and estuarine habitat quality; and impacted migration habitat due to elevated in-air and underwater sound, human activity, and vessel perturbations. In addition, Hood Canal has experienced frequent hypoxia events. Shoreline modifications have led to fragmentation, reduced productivity, and diminished resiliency of species that use the nearshore. As of 2011, Schlenger et al. (2011 p 96) estimated nearly 7,000 overwater structures in Puget Sound, and one quarter of the shoreline was armored (NMFS 2021 p. 98; Schlenger et al. 2011 p.67; Simenstad et al. 2011). Beechie and others (2017) estimated nearly 1600 acres of overwater structure within the action area between 2013 and 2016 (Table 3). 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 (Table 4) (NMFS 2021 p. 98; Beechie et al 2017). 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.

Table 3. Total area of over water structures by sub-basin observed in aerial photo review between 2013 and 2016.

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

(Beechie et al 2017; NMFS 2020 p.85)

Table 4. Length of shoreline armored as a percent of total shoreline length.



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%**

(Simenstad et al. 2011; MacLennan et al 2017)

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, diminished prey availability, diminished aquatic habitat availability, diminished invertebrate colonization, and diminished forage fish populations (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; NMFS 2021 p. 101). 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 (*Ammodytes hexapterus*) and surf smelt (*Hypomesus pretiosus*)) 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 (Whitman et al. 2014).

The following describes the existing conditions for forage resources and their habitat within the action area available to bull trout and marbled murrelet after factoring the current condition of the nearshore area and land use and development.

10.1 Existing Conditions for Native Eelgrass

Eelgrass (*Zostera marina)* beds are vital habitat for various forage species important to both marbled murrelets and bull trout. Species that use the nearshore habitat provided by eelgrass beds include forage fish species such as Pacific herring (*Clupea pallasii*), surf smelt and sand lance but also juvenile Pacific salmon (*Oncorhynchus* spp.). These native forage species provide the high-quality prey resource and energetic needs of marbled murrelet and bull trout. Results from Kennedy et al (2018 p. 198) suggest that while eelgrass beds are particularly important for forage species, including invertebrates, the prey community composition remained similar across a gradient of eelgrass density. Given eelgrass beds interspersed through the Salish Sea are characterized as variable densities, patchy and sparse (Kennedy et al 2018; Christiaen et al 2022; Wright 2014), the habitat value of these beds, regardless of size or density may provide similar invertebrate and forage communities.

A long-term monitoring program for eelgrass and submerged aquatic vegetation has been in place for 20 years in Puget Sound (Gaeckle et al 2011; 2015; Christiaen et al 2016; 2017; 2022). In recent years (2016 – 2020), the Soundwide area of eelgrass declined after long-term stability and/or increases between 2004 and 2016 (Christiaen et al 2022 p. 2). However, eelgrass population declines are not statistically significant (Figure 2; Christiaen et al 2022 p.2). The annual estimates of soundwide eelgrass area were 21,283 +/- 1,5711 ha in 2018, 23,512 +/- 1,864 ha in 2019, and 22,845 +/- 1,864 ha in 2020. The 3-year soundwide average for 2018-2020 was approximately 22,100 +/- 1,100 ha (Figure 2; Christiaen et al 2022 p.2).

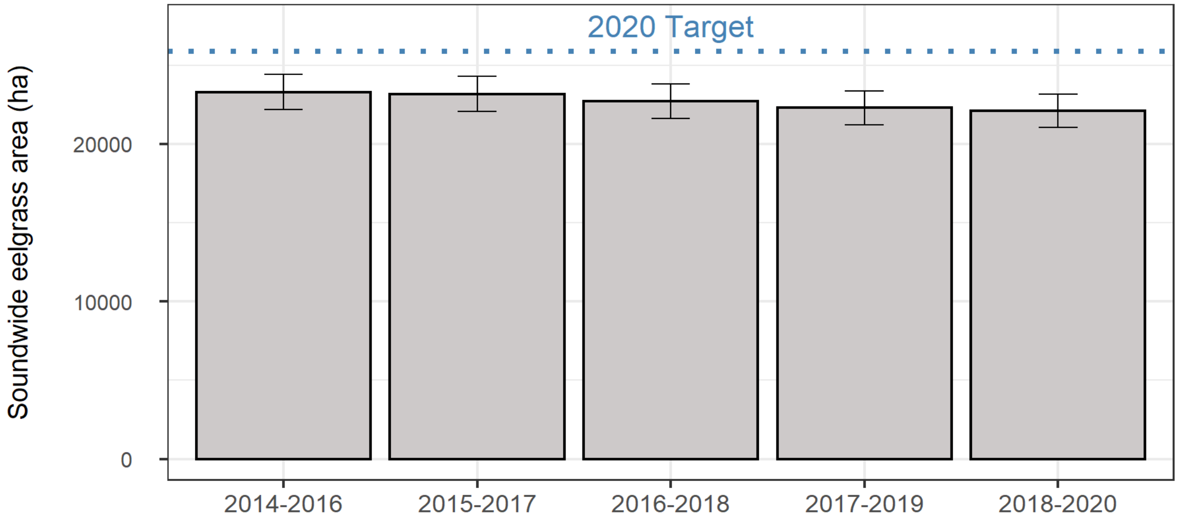


Figure 2. Estimates of soundwide eelgrass area (ha) based on pooled 3-year samples in greater Puget Sound. The dotted blue line indicates the recovery target relative to the 2000-2008 baseline.
(Source: Christiaen et al 2022 p. 2)

The most recent eelgrass monitoring report also found the San Juan Islands and Cypress Island had significant declines of eelgrass over the long-term (2000-2020) and in recent years (2015-2020) (Christiaen et al 2022 p. 1). The largest declines occurred in embayments and are likely from a variety of stressors including physical damage, water quality impairments and eelgrass wasting disease (Christiaen et al 2022 p. 1). In the Skagit River delta, as well as the Skokomish and Nisqually River deltas, notable fluctuations and declines of eelgrass populations were documented (Christiaen et al 2022 p. 1).

10.2 Existing Conditions for Marine Forage Fish

Forage fishes in general, and Pacific herring specifically, are vital components of the marine ecosystem and foodweb (Chamberlin et al 2021 Abstract; Kennedy et al 2018 p. 190; McDevitt et al 2016 p. 133). They also provide a valuable indicator of the overall health of the marine environment (Stick et al 2014 p. 1; PSP 2021). Significant predation occurs at each stage of the herring life cycle, starting with predation on deposited spawn by invertebrates, gulls, and diving birds. Reflecting the importance of herring in the Puget Sound ecosystem, the spawning biomass of Puget Sound herring was selected as a vital sign indicator of the health of Puget Sound by the Puget Sound Partnership" (Stick et al 2014, p.1; PSP 2021).

Forage fish are loosely defined as small, schooling fishes that form critical links between the marine zooplankton community and larger predatory fish, seabirds, and marine mammals in the marine food web (Penttila 2007, Executive Summary; PSAT 2007). The three most common marine forage fish species in Puget Sound are Pacific herring, surf smelt, and Pacific sand lance. These species and their spawning habitats all commonly occur on Puget Sound beaches and in the intertidal zone, and all three species use adjacent nearshore habitats as nursery grounds.

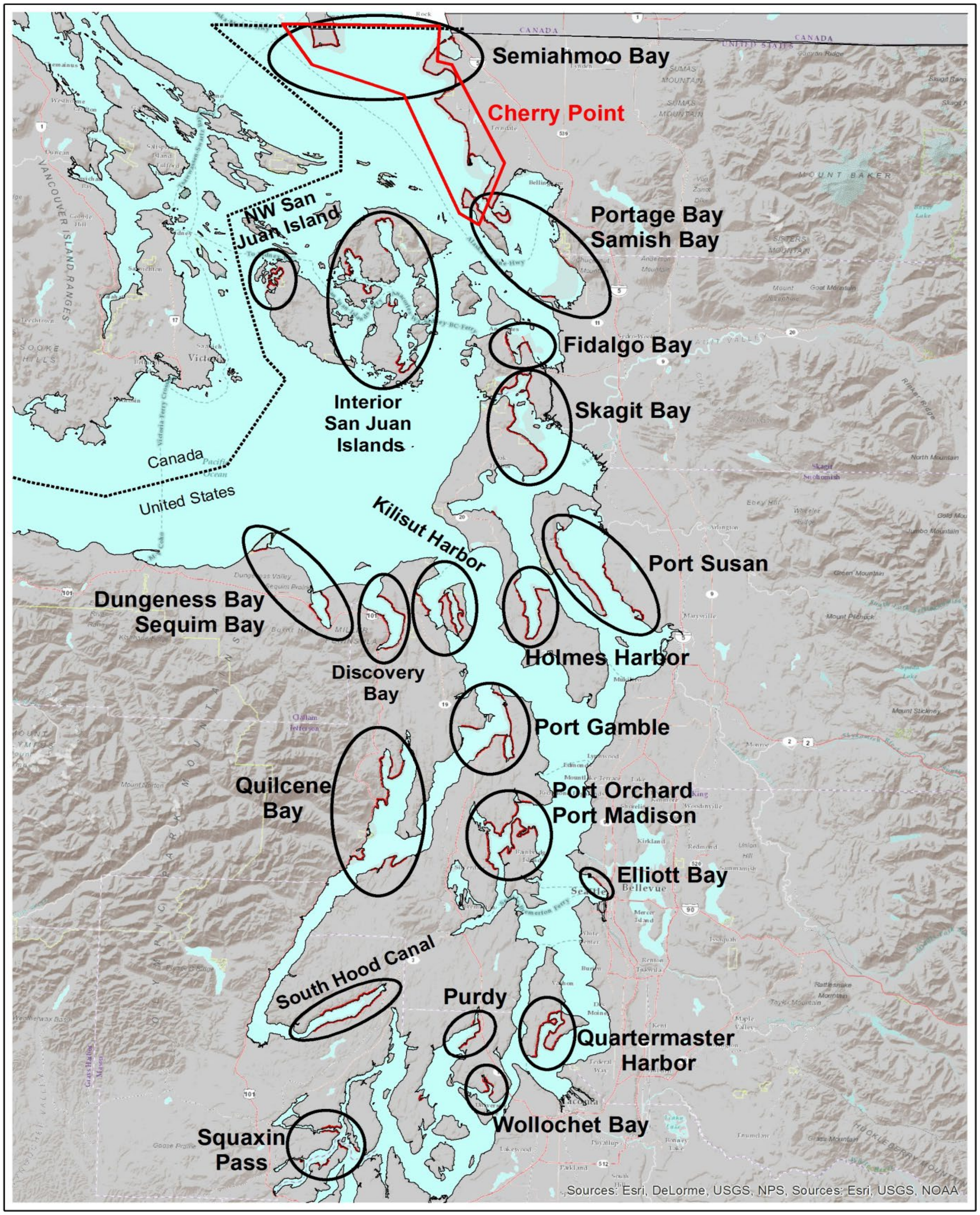
Within the Puget Sound Basin, where their spawning areas have been most completely mapped, each species appears to use approximately 10 percent of the shoreline spawning habitat during the year (Penttila 2007, Executive Summary). Other marine forage fish species include northern anchovy, eulachon or Columbia River smelt, and longfin smelt. These species do not spawn in Puget Sound but do contribute to the total biomass of marine forage fish in Puget Sound (Penttila 2007, Executive Summary).

Some months before the onset of spawning activity, ripening Pacific herring begin to assemble adjacent to spawning sites in pre-spawning holding areas (Penttila 2007, pp. 6-8). They spawn by depositing their eggs on eelgrass, algae, hard substrates, man-made structures (such as pilings), and occasionally polychaete tubes. Figure 5 identifies most of the documented spawning areas in Puget Sound; two spawning locations only recently documented, Elliot Bay and Purdy (Stick et al 2014, p. 11), are not depicted. Most egg deposition occurs from 0 to -10 ft MLLW (Bargmann 1998), but in some areas spawning can occur as deep as - 32 ft (-10 m) (Penttila 2007, pp. 6-8). Following hatching, the larvae drift in the currents. Following metamorphosis, young herring spend their first year in Puget Sound; some then spend their entire lives within Puget Sound, while others migrate to the open ocean to mature. Most spawning occurs between mid-January and March.

Surf smelt are common, year-round residents in the nearshore areas of Puget Sound. They are a short-lived fish with most spawning populations comprised of 1- and 2-year old fish (WDFW 2019c p. 1). Spawning occurs on mixed-sand and gravel substrates in the upper intertidal zone, generally higher than +7 ft MLLW (Penttila 2007, pp. 3, 8-10; WDFW 2019c p. 1). It appears that surf smelt spawn year-round in portions of Puget Sound. There is no information on movement patterns and no evidence of seasonal migration out the Strait of Juan de Fuca. Their home ranges are unknown and there has been no region wide assessment of stock status (Penttila 2007, pp. 3, 8-10). The WDFW has documented spawning habitat on approximately 200 lineal miles of Puget Sound shoreline (WDFW 2019 p. 2-4).

Pacific sand lance (or candlefish) are common, year-round residents in the nearshore areas of Puget Sound. They feed on macrozooplankton. During spring and summer months, Pacific sand lance are considered epibenthic, schooling pelagically during the day to forage, and burrowing in the benthic substrate at night (Penttila 2007, pp. 3, 4, 10, 11; WDNR 2014 p.1). Their home ranges are unknown and there has been no region-wide assessment of stock status. Juveniles may be more closely associated with shorelines and protected bays, often found in mixed schools with Pacific herring and surf smelt of similar age and size. There is no information on movement patterns and no evidence of seasonal migration out the Strait of Juan de Fuca.

The overall status of forage fish species (herring, sand lance and smelt) is reflective of the impact of development within the Salish Sea and correlates with the changes in eelgrass distribution over time. The 2014 stock assessment for herring indicated that there was a continued drop in the number of herring stocks in Puget Sound that were qualified as healthy or moderately healthy for the monitoring years 2011-2012 (Stick et al 2014 p. 60). In addition, two herring stocks (N.W. San Juan and Kilisut Harbor) were not detectable, and the Cherry Point stock showed no signs of improvement from its critical status (Stick et al 2014 p. 60). Most recent biomass indices from Puget Sound Partnership Vital Signs monitoring show declines in most stocks of Pacific herring, except in Hood Canal and Central Puget Sound (Figure 4; PSP 2022).



Sources: Esri, DeLorme, USGS, NPS, Sources: Esri, USGS, NOAA

Figure 3. Documented Puget Sound Herring Spawning Grounds
(Source: Stick et al 2014 p. 11)

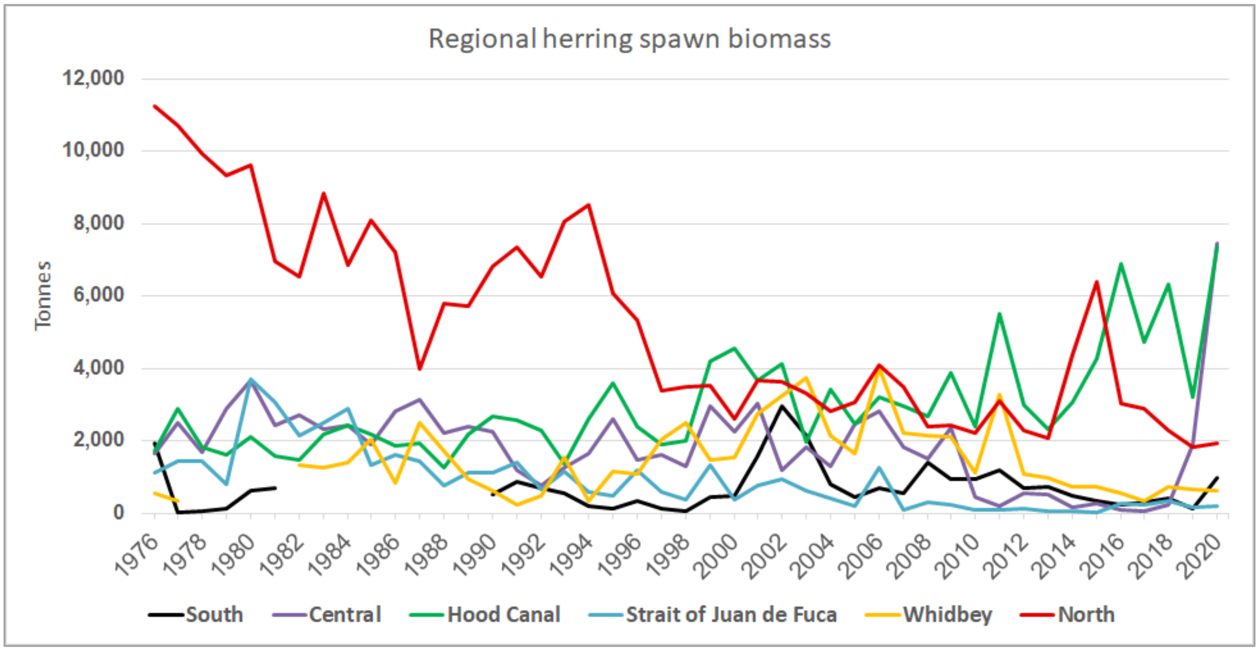


Figure 4. WDFW 2020 Biomass of spawning Pacific herring Vital signs indicator (PSP 2022)

Selleck et al. (2015) recently published the first synthesis of historical sand lance capture records for the inland waters of Washington State. The report highlighted the lack of historical data on population distribution and density throughout Puget Sound and provided a summary of beach seine and tow net data in nearshore shallow areas (Selleck et al 2015 p. 185). Much of the existing research shows a link between sand lance sites and juvenile rearing Chinook (Duffy et al 2010) as well as a common prey item of marine diving birds (murres, rhinocerous auklets, and marbled murrelets (Selleck et al 2015 p. 185; Lance and Thompson 2005; Norris et al 2007). Selleck et al. (2015) surmised numerous data gaps exist on the ecological importance and impacts of anthropogenic activities have on the populations of sand lance.

Pacific herring, smelt species, Pacific sand lance, and northern anchovy are important prey species for higher trophic level species but provide varying energetic value. The energy content of a forage fish 80-100 mm in length is 40 kJ/fish for smelt species, 32kJ/fish for Pacific herring, 58 kJ/fish for Northern anchovy, and 10 kJ/fish for Pacific sand lance (Gutowsky et al 2009). The energetic loss incurred by reduced stocks of higher energetic value forage fish species such as Pacific herring and smelt species cannot be mediated by an increased diet proportion of lower energetic value species such as sand lance without increased foraging effort.

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 (NMFS 2021 p. 97). 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 (NMFS 2021 p. 97), and thus likely provide high quality forage for bull trout.

Significant data gaps exist on the full relationship of forage fish populations, density, and distribution in relation to the development impacts across the action area. However, the relation of lost eelgrass habitat to urban and shoreline development combined with the importance of this habitat to forage fish species suggests a strong likelihood of declines in forage fish in the action area and the overall health of the Puget Sound marine ecosystem. Forage fish are the base of the marbled murrelet diet. Forage fish as well as juvenile salmon are an important prey resource for bull trout.

10.3 Bull Trout and Designated Bull Trout Critical Habitat

To understand bull trout in the action area, it is necessary to briefly discuss bull trout in a broader area, including Recovery Units, Core Areas and CHUs. The action area for the proposed action includes the entirety of marine and estuarine areas associated with the Salish Sea. Bull trout are listed as a single Distinct Population Segment (DPS) across five states in the lower contiguous United States; the DPS is divided into six Recovery Units across the range (USFWS 2015a). Each Recovery Unit is further broken into multiple Core Areas or metapopulations of bull trout. The Salish Sea falls within the Coastal Recovery Unit, which includes bull trout from 25 existing and historic Core Areas across western Washington and Oregon. Within the action area, the Coastal Recovery Unit is divided into two geographic regions: Puget Sound and Olympic Peninsula. The Puget Sound and Olympic Peninsula geographic regions are entirely within Washington. The Puget Sound geographic region contains eight core areas, and the Olympic Peninsula geographic region contains six Core Areas (USFWS 2015b pp. A-148 to A-151). The Puget Sound and Olympic Peninsula geographic regions contain the anadromous life history form. Within the Olympic Peninsula geographic region, three Core Areas (Hoh, Queets and Quinault) fall outside of the action area along the outer coast of Washington. Two core areas within the Puget Sound geographic Region, the Upper Skagit River and Chester Morse, are isolated above one or more dams and only contain fluvial, adfluvial, and resident life history forms. Therefore, these five core areas are not discussed further in this document.

Anadromous bull trout forage, migrate, and overwinter along the nearshore (generally in water less than 10 meters deep) and are opportunistic foragers, often traveling to access and take advantage of seasonally abundant food resources. The extent of this utilization is poorly understood; however, Kraemer (1994, p. 13) speculated that bull trout distribution in marine waters depends on the distribution of forage fish and their spawning beaches. In general, anadromous bull trout use shallow nearshore, subtidal, and intertidal waters. In two acoustic telemetry projects, the greatest bull trout densities were at depths greater than 2.0 to 2.5 meters, up to depths as great as 25 m (Goetz et al. 2004; USGS 2008). Upon entering marine waters, bull trout can make extensive, rapid migrations, usually in nearshore marine areas. However, bull trout have also been tracked crossing Puget Sound at depths greater than 183 m (600 ft) (Goetz et al. 2012).

Bull trout move from freshwater to marine areas between March and July; the majority of bull trout individuals return to freshwater tributaries by August (Hayes et al 2011; Goetz et al 2012). During the majority of their marine residency, anadromous bull trout have been found to occupy territories ranging in size from approximately 10 m to more than 3 km within 100 to 400 m of the shoreline (USGS 2008). Aquatic vegetation and substrate common to bull trout marine habitat include eelgrass, green algae, sand, mud, and mixed fine substrates. Forage fish occurrence is also correlated with these habitat features. Bull trout prey on surf smelt, Pacific herring, Pacific sand lance, and other small schooling fish, especially keying in on their spawning beaches (Kraemer 1994). Bull trout have also been noted to feed heavily on shiner perch at some locations (Berge, pers comm 2003).

Anadromous bull trout prey on surf smelt, Pacific herring, sand lance, juvenile salmonids, and other small schooling fish while in the marine environment (Kraemer 1994, pp. 12-13; WDFW 1997). Eelgrass meadows and other complex nearshore marine and estuarine habitats are a focal point for their foraging activities and provide essential prey resources. Anadromous bull trout foraging in marine waters can grow more rapidly than bull trout in rivers (Kraemer 1994, pp. 10-12).

We expect that some level of mixing or interaction within marine waters occurs among anadromous individuals from various core areas. Although studies have documented bull trout moving into non-natal rivers via marine waters (WDFW 1997; Goetz et al 2021), we do not understand the full extent of this behavior.

Based on these studies, anadromous bull trout from several different core areas may be present within the action area simultaneously. Bull trout in the Strait of Juan de Fuca, Hood Canal, and Puget Sound may come from multiple Core Areas that flow into these marine waters, including Chilliwack, Lower Skagit, Nooksack, Stillaguamish, Snohomish/Skykomish, Puyallup, Skokomish, Dungeness, and Elwha (Figure 5). For each Core Area, the USFWS provides a brief summary of the status and trend based on existing information on population estimates, redd counts or other demographic data combined with existing threats identified as impacting the long-term persistence of bull trout.

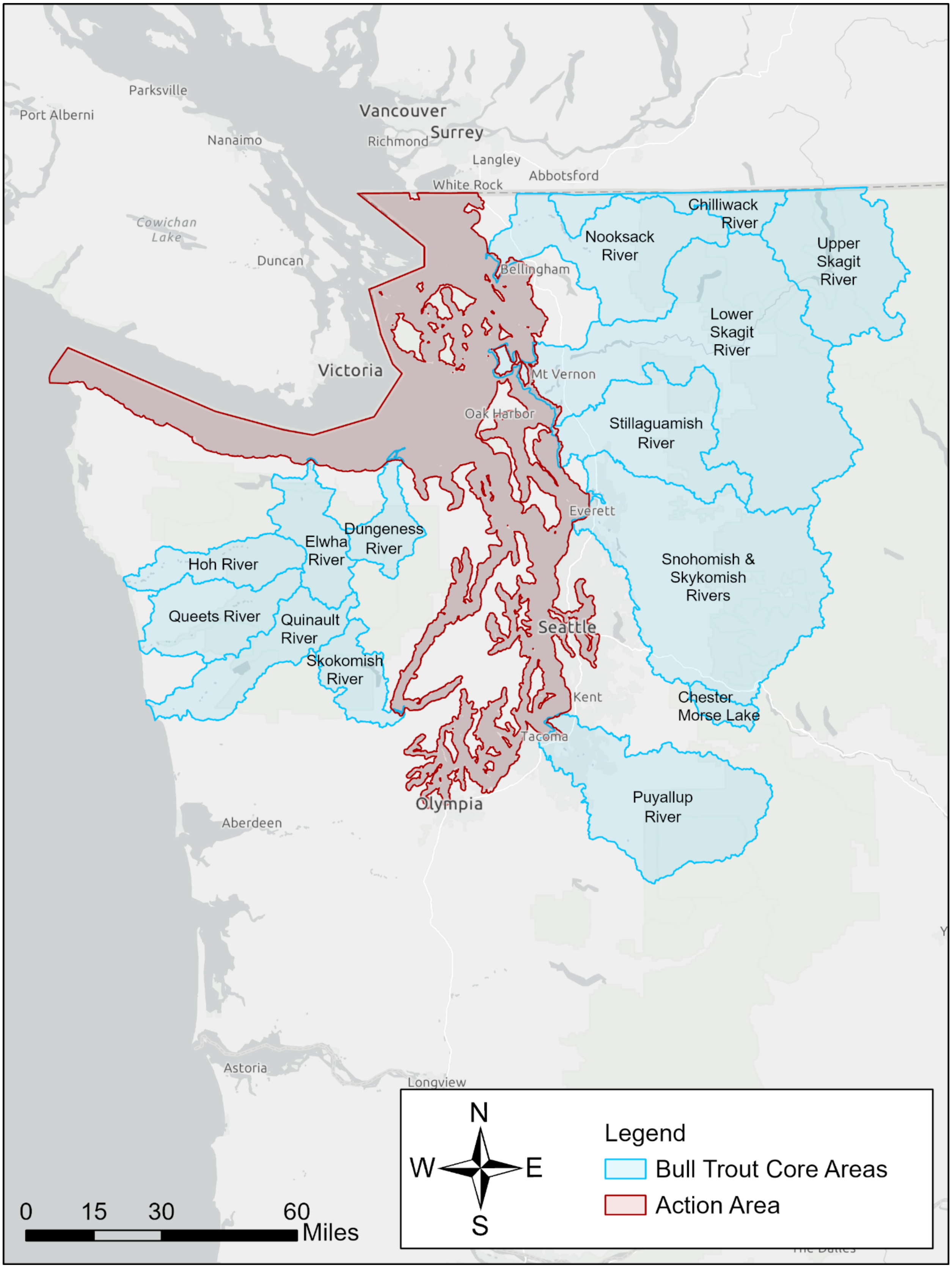


Figure 5. Map of bull trout core areas in relation to the Action Area for the SSNP.

10.3.1 Puget Sound Region

Puget Sound nearshore and estuarine habitats have been severely degraded due to development (USFWS 2015a, p. A-17). Residential and industrial development have resulted in increased bank armoring, and expansions of marinas, piers, and docks. These habitat impacts have resulted in impacts to bull trout and also their prey species. Juvenile salmon migration and foraging have been impacted and marine forage fish spawning areas have been lost or altered. In most areas, these threats are ongoing and persistent. However, restoration actions including estuary rehabilitation, fish passage improvements and levee setbacks are providing improvements to habitat. These benefits are achieved over time and may not be immediately measurable.

In 2015, the Puget Sound geographic region had three core areas that were considered bull trout population strongholds, the Lower Skagit, Upper Skagit and Chilliwack, and two core areas, the Puyallup River and Stillaguamish River, that were identified as having small population sizes (USFWS 2015a, p. A-27). Some core areas have long-term data that can be used to provide information on the status of bull trout, with that information potentially extrapolated to other core areas when information is lacking. Bull trout within individual core areas within the Coastal Recovery Unit are monitored or surveyed at different levels and frequency. Based on bull trout monitoring surveys through 2019, the Puget Sound geographic region of the Coastal Recovery Unit is showing unstable and declining bull trout numbers in several core areas.

Within the Puget Sound geographic region, there are no physical barriers to bull trout migrating between core areas that enter into Puget Sound. Bull trout are known to migrate from one core area to another core area, a non-core area (smaller rivers that enter into Puget Sound), or foraging, migration, and overwintering areas (Duwamish River, Lake Washington, etc.). For example, bull trout have been observed migrating from the Snohomish River core area down to the Duwamish River and then returning (Goetz, et al 2012).

Bull trout occur regularly throughout the nearshore marine areas of the north Puget Sound. There are ongoing studies of bull trout use of the Puget Sound nearshore by the Corps (Goetz et al. 2004; Goetz et al. 2022). In two telemetry studies documenting the extent of anadromy in bull trout within portions of the Coastal Recovery Unit, approximately 55 percent of the fish tagged in freshwater emigrated to saltwater (Brenkman and Corbett 2005; Goetz et al. 2007). Over 160 bull trout have been radio tagged in north Puget Sound, including the Lower Snohomish River and Skagit Bay, with results demonstrating that anadromous bull trout inhabit a diverse range of estuarine, freshwater, and marine habitats. The residency period varied slightly for the two years data are available. In 2002, 98 percent of the tagged bull trout left the marine areas by late July. A single bull trout remained until August 12 in brackish water. In 2003, over 95 percent of the tagged bull trout left marine areas by early July. The USFWS assumes variable levels of spawning migrations occur across the action area, and therefore during the marine residency period (March through July), up to 55 percent of the anadromous adult and subadult migratory individuals from each core area could enter Puget Sound (Brenkman and Corbett 2005; Goetz et al. 2007; Goetz et al. 2021). Given the studies above indicating that over 95 percent of bull trout have left marine waters by August, but are based on very low numbers, the USFWS conservatively assumes fewer than 25 percent of the anadromous bull trout would remain in marine areas during the non-marine residence period (August through March).

In general, anadromous bull trout use shallow nearshore, subtidal, and intertidal waters. In two acoustic telemetry projects, the greatest bull trout densities were at depths greater than 2.0 to 2.5 meters, up to depths as great as 25 m (Goetz et al. 2004; USGS 2008). Upon entering marine waters, bull trout can make extensive, rapid migrations, usually in nearshore marine areas. However, bull trout have also been tracked crossing Puget Sound at depths greater than 183 m (600 ft) (Goetz et al. 2012).

During the majority of their marine residency, anadromous bull trout have been found to occupy territories ranging in size from approximately 10 m to more than 3 km within 100 to 400 m of the shoreline (USGS 2008). Aquatic vegetation and substrate common to bull trout marine habitat include eelgrass, green algae, sand, mud, and mixed fine substrates. Forage fish occurrence is also correlated with these habitat features. Bull trout prey on surf smelt Pacific herring, Pacific sand lance, and other small schooling fish, especially keying in on their spawning beaches (Kraemer 1994). Bull trout have also been noted to feed heavily on shiner perch at some locations (Berge, pers comm 2003).

Bull trout may also seasonally use reaches of river systems and estuaries that are unlikely to support spawning populations of bull trout, such as the Samish River and Duwamish River. Bull trout may forage on juvenile salmonids or other fish species while occupying these areas. The extent of past and current bull trout use of smaller, independent creek drainages that discharge directly into Puget Sound is not well known, with only a few known reported observations. While many of the small stream systems in Puget Sound are not commonly occupied by bull trout, these streams still provide an important contribution to the potential forage base for bull trout using adjacent nearshore marine waters or other parts of Puget Sound.

10.3.2 Chilliwack Core Area

The Chilliwack core area comprises those portions of the Chilliwack River and its major tributaries, including Silesia and Tomyhoi Creeks, and the Sumas River in the United States. The Chilliwack River is a transboundary system flowing from the United States northwest into British Columbia. The British Columbia portion of the Chilliwack system is functionally part of the core area. Three local populations have been identified in the United States portion of this core area: 1) Upper Chilliwack River (including Easy, Brush, and Indian Creeks), 2) Little Chilliwack River, and 3) Silesia Creek. An additional seven local populations have been identified in British Columbia. The Chilliwack core area likely supports between 500 and 750 adults in the three United States local populations. However, with inclusion of the local populations in Canada, the Chilliwack system likely supports well over 1,000 adults.

The majority of the core area in the United States is in Federal ownership and in excellent to pristine condition, except habitat affected by agricultural practices along the Sumas River. Threats to the bull trout in the Chilliwack core area result primarily from forest management activities in Canada (USFWS 2015b p. A-11). In British Columbia, the status of the Chilliwack River stock of bull trout is categorized as at “presumed conservation risk” (i.e., current threats are believed to be significantly affecting the population or population is considered at risk) (BCMWLAP 2002).

Adfluvial, fluvial and, potentially, resident and anadromous life history forms of bull trout occur in the Chilliwack core area. The level of use and distribution of bull trout into the action area is generally unknown and not well understood. However, the USFWS expects fewer bull trout individuals from the Chilliwack Core Area in the action area due to high quality habitat within the basin and unknown levels of anadromy and most bull trout will congregate near the Chilliwack estuary and around Vancouver Island in Canada outside of the action area. Therefore, we assume fewer than 200 adults and subadults may enter the action area.

10.3.3 Nooksack Core Area

The Nooksack River core area comprises the Nooksack River and its tributaries. Fluvial and anadromous are the most abundant life history forms in the Nooksack River core area. Bull trout from the Nooksack River core area are known to utilize marine waters at least as far south as the Swinomish Channel in Puget Sound, based on limited acoustic tagging efforts (Goetz et al. 2007). Bull trout and Dolly Varden (*S. malma*) co-occur in the Nooksack River core area, but the level of interaction between the two species and degree of overlap in their distributions is unknown. Limited genetic analysis and observational data suggest Dolly Varden in this core area inhabit stream reaches above barriers to anadromous fish, while bull trout primarily occupy the accessible stream reaches below the barriers.

Ten local populations are recognized within the Nooksack River core (USFWS 2015b p. A-149). Spawning areas used by the local populations are believed to be small. The Nooksack River core area adult abundance is estimated between 500 to 1,000 individuals based on limited spawn survey data. Eight of the local populations likely have fewer than 100 adults each, based on the relatively low number of migratory adults observed returning to the core area. The Nooksack River core area appears to be stable. Where long-term bull trout survey data is available, the number of bull trout observed in Thompson Creek during salmon spawning surveys has been stable or slightly increasing (WDFW 2011-2021). More survey data are needed in the Nooksack River core area to make any specific short-term trend on abundance of bull trout.

There are three primary threats to bull trout in the Nooksack River core area (USFWS 2015b p. A-11). Impacts associated with legacy forest management and agricultural practices, seasonal high water temperatures in the South Fork Nooksack River, and connectivity impairments in the Middle Fork Nooksack impact habitat areas utilized for foraging, migration and overwintering and are key to the persistence of the anadromous life history form. Impacts to marine foraging habitats have been, and continue to be, greatly affected by urbanization along nearshore areas in Bellingham Bay and the Strait of Georgia and are recognized as impacting anadromous bull trout. For example, the Cherry Point herring stock was once a substantial prey resource, and its current diminished condition likely impacts bull trout fitness and resiliency.

The USFWS expects bull trout from the Nooksack Core Area to be present in the action area. Up to 55 percent of the adult and subadult population (approximately 550 individuals) is expected within the action area at any time and distributed broadly through northern Puget Sound and around the Nooksack River estuary.

10.3.4 Lower Skagit Core Area

The Lower Skagit core area comprises the Skagit basin downstream of Seattle City Light's Gorge Dam, including the mainstem Skagit River and the Cascade, Sauk, Suiattle, White Chuck, and Baker Rivers, including the reservoirs (Baker Lake, Lake Shannon) upstream of upper and lower Baker Dams. Twenty local populations are recognized within the Lower Skagit core area (USFWS 2015b p. A-148). Bull trout occur throughout the Lower Skagit core and express fluvial, adfluvial, resident, and anadromous life history forms. Many subadult and adult bull trout use the lower river, estuary, and nearshore marine areas extensively for rearing and foraging. Key spawning and early rearing habitat, found in the upper portions of much of the basin, is generally on federally protected lands, including the North Cascades National Park, North Cascades National Recreation Area, Glacier Peak Wilderness, and Henry M. Jackson Wilderness Area.

The Lower Skagit core area is believed to contain the largest spawning population of bull trout in Washington. Adult abundance is estimated to be between 5,000 and 10,000 individuals based on partial spawner survey data from less than half of the core area (USFWS 2008a, p. 3). Bull trout redd counts have been conducted since 2002 in the Lower Skagit River core area. Peak number of redds occurred in 2006 (855 redds) and 2014 (1010 redds). Between 2015 and 2019, the number of bull trout redds has decreased to the lowest number (175 redds observed in 2019) since 2002. Similarly, the 5-year mean shows a decline in bull trout redd numbers between 2014 and 2019. Redd numbers have decreased in most streams, with lowest numbers being found in Illabot Creek (7 redds), SF Sauk River (20 redds), and Downey Creek (21 redds). Based on these data sets, while habitat quality is relatively good across the core area, bull trout abundance appears to be declining (McKinney et al 2022 p. 2). With the decrease in redd numbers in the Lower Skagit River core area, a similar decrease has been observed in captures of juvenile bull trout in the lower Skagit River screw traps (WDFW 2011-2021).

The Baker River Hydroelectric Facility captures adult bull trout for transportation above the dams as well as juvenile bull trout for downstream passage. Upstream passage of adult bull trout has declined from 2015 to 2019, but the low number transported in 2019 (10 adults) is similar to those transported upstream in 2006 and 2007 (PSE 2019, 2020). Downstream captures of juveniles at Upper Baker Reservoir have also declined from 2015 (129 juveniles) to 2019 (32 juveniles), but juvenile numbers captured in Lower Baker Reservoir had the second highest captured in 2018 (28 juveniles) since 2003 (PSE 2019, 2020). In 2015, 81 juvenile bull trout were captured in Lower Baker Reservoir. The Lower Skagit River core area was considered a bull trout stronghold, but redd numbers, screw trap numbers, and observations of adult bull trout during spawning surveys, all indicated a downward trend in bull trout abundance.

There are five primary threats to bull trout in the Lower Skagit core area (USFWS 2015b, pp. A-11 to A-12): Legacy Forest Management; Flood Control; Agriculture Practices and Residential Development and Urbanization; Climate Change; and Fish Passage Issues. Similar to the Nooksack, impacts to estuarine nearshore foraging habitats and declines in forage fish species, particularly surf smelt and Pacific herring, in the marine nearshore areas of the Salish Sea (Therriault et al. 2009; Greene et al. 2015) likely limit the resiliency and fitness of the anadromous life history form. Declines in abundance of anadromous salmonids have reduced the bull trout forage base and may limit the abundance and productivity of the core area's bull trout populations (USFWS 2008a, p. 15).

Anadromous salmonids are vital to Lower Skagit core area bull trout because they provide an abundant forage resource. However, the abundance of many species of anadromous salmonids in the Lower Skagit core area has been in decline for a decade (chum salmon, *Oncorhynchus keta*) or more (Chinook salmon, *O. tshawytscha*, and steelhead trout, *O. mykiss*) (WDFW 2015c). Bull trout abundance and growth rates are positively correlated with abundance of spawning anadromous salmonids in the Lower Skagit core area (Kraemer 2003, pp. 5, 9-10; Zimmerman and Kinsel 2010, pp. 26, 30) and elsewhere (Copeland and Meyer 2011, pp. 937-938).

Given the correlation of declining bull trout numbers and declining salmon numbers in the Lower Skagit Core Area, there is strong evidence that a large portion of the population exhibits anadromy. Therefore, the USFWS expects up to 1000 adult and subadult bull trout individuals may be in the action area during the year. We expect these individuals will be primarily distributed broadly throughout northern Puget Sound and in the Skagit River Estuary.

10.3.5 Stillaguamish Core Area

The Stillaguamish core area is comprised of the Stillaguamish River basin, including the North Fork and South Fork Stillaguamish Rivers and their tributaries. Three local populations are recognized within the Stillaguamish core area: 1) Upper Deer Creek, 2) South Fork Stillaguamish River, and 3) Canyon Creek. These local populations are relatively well-distributed throughout the core area. The Upper Deer Creek local population may be extirpated (USFWS 2015, p. A-13), based on the paucity of historical observations of bull trout and more recent failures to detect bull trout. Bull trout in the Stillaguamish core area primarily consist of the anadromous and fluvial life-history forms (USFWS 2004, p. 96). Resident bull trout occur in the upper South Fork Stillaguamish River (USFWS 2004, p. 98; USFWS 2008a, p. 1) and possibly also upstream of the anadromous barrier on Higgins Creek (USFWS 2008a, p. 3).

The Stillaguamish core area likely contains fewer than 1000 adults, however survey data is limited and origin of fish observed in the former North Fork Stillaguamish River local population is uncertain. Extremely low numbers of bull trout redds were observed between 2017 and 2019. The Stillaguamish River is identified as having low population abundance and has had only one bull trout redd identified between 2016 and 2019. In 2014 and 2015, ten bull trout redds were found in the Stillaguamish River. The highest number of bull trout redds were found in 2006 with 67 redds, and in 2008 with 64 redds. Bull trout redd numbers within the Stillaguamish River have always been low, with less than 30 redds occurring 12 times between 2002 and 2019. Bull trout abundance within the Stillaguamish River core area is inferred to be extremely low based on redd counts.

Six primary threats to bull trout in the Stillaguamish core area were identified from forest management, recreational mining, residential development and urbanization, fish passage issues, and small population size (USFWS 2015, p. A-13). Impacts to estuarine nearshore foraging habitats and declines in forage fish species, particularly surf smelt and Pacific herring, in the marine nearshore areas of the Salish Sea likely have a greater impact on the small declining populations in the Stillaguamish core area.

Given the very small and declining population size of the Stillaguamish Core Area, the USFWS expects fewer than 55 adult and subadult individuals may be present in the action area. It is likely that most of these individuals will be distributed throughout the northern portions of Puget Sound.

10.3.6 Snohomish/Skykomish Core Area

The Snohomish-Skykomish core area comprises the Snohomish, Skykomish, and Snoqualmie Rivers and their tributaries. Bull trout occur throughout the Snohomish River system downstream of barriers to anadromous fish. Bull trout are not known to occur upstream of Snoqualmie Falls, upstream of Spada Lake on the Sultan River, in the upper forks of the Tolt River, above Deer Falls on the North Fork Skykomish River, or above Alpine Falls on the Tye River. Fluvial, resident, and anadromous life history forms of bull trout occur in the Snohomish-Skykomish core area. A large portion of the migratory segment of this population is anadromous.

Four local populations are recognized within the Snohomish-Skykomish core area (USFWS 2004, pp. 99-105; USFWS 2015b, p. A-14): 1) North Fork Skykomish River (including Goblin and West Cady Creeks), 2) Troublesome Creek (resident form only), 3) Salmon Creek, and 4) South Fork Skykomish River. Based on redd counts and number of adults passed over Sunset Falls (85 percent decline since 2006), trend information for bull trout in the Snohomish/Skykomish River core area also appears to be declining. The Snohomish-Skykomish core area probably supports between 500 and 1,000 adults. In 2008, it was believed that this core area supported just over 1,000 adults (USFWS 2008a, p. 2; USFWS 2008b, p. 35). However, abundance indices in the two primary local populations (North Fork Skykomish River and South Fork Skykomish River) have substantially declined since then (WDFW 2015c).

USFWS (2015b p.A-14) identified four primary threats to bull trout in the Snohomish-Skykomish core area: Flood Control, Recreational Mining, Residential Development and Urbanization and Fish Passage Issues. As with other Puget Sound core areas, impacts to forage base and marine nearshore habitat likely significantly reduce fitness and resiliency of individual bull trout given the high frequency of anadromy in this core area.

The USFWS expects up to 55 percent (approximately 550 individuals) of the adult population in the Snohomish/Skykomish Core Area may be distributed throughout the northern and central portions of Puget Sound.

10.3.7 Puyallup Core Area

The Puyallup core area comprises the Puyallup, Mowich, and Carbon Rivers; the White River system, which includes the Clearwater, Greenwater, and the West Fork White Rivers; and Huckleberry Creek. Glacial sources in several watersheds drain the north and west sides of

Mount Rainier and significantly influence water, substrate, and channel conditions in the mainstem reaches. The location of many of the basin's headwater reaches within Mount Rainier National Park and designated wilderness areas (Clearwater Wilderness, Norse Peak Wilderness) provides relatively pristine habitat conditions in these portions of the watershed. Anadromous, fluvial, and potentially resident bull trout occur within local populations in the Puyallup River system. Anadromous and fluvial bull trout use the mainstem reaches of the Puyallup, Carbon, and White Rivers to forage and overwinter, while the anadromous form also uses Commencement Bay and likely other nearshore areas within south Puget Sound.

Five local populations occur in the Puyallup core area: 1) Upper Puyallup and Mowich Rivers, 2) Carbon River, 3) Upper White River, 4) West Fork White River, and 5) Greenwater River. The Puyallup River core area, considered to have small population numbers has had increased numbers of bull trout passed over Mud Mountain Dam since 2008 and an increase in bull trout redd numbers. In recent years, substantial efforts by the Puyallup Tribe and others have occurred to document abundance and movements of bull trout in the Puyallup River core area (Marks et al 2019, 2020; Johnson 2021). Currently, fewer than 100 adults probably occur in each of the local populations in the White River system, based on adult counts at Mud Mountain Dam's Buckley Diversion fish trap and redd counts. Overall, the USFWS estimates that the total population of adult breeding bull trout in the Puyallup Core Area is between 100-500 individuals.

Several primary threats were identified in the Puyallup River core area (USFWS 2015b p. A-16) including:

> Extensive past and ongoing timber harvest and harvest-related activities
>
> Agricultural practices, such as bank armoring, riparian clearing, and non-point discharges of chemical applications
>
> Dams and diversions affecting migratory corridors
>
> Non-native species such as brook trout within spawning areas
>
> Degraded water quality due to municipal and industrial effluent discharges in marine, estuarine, and river migratory and foraging habitat.

Water quality and impacts to nearshore foraging areas in South Puget Sound likely limit the resiliency of anadromous bull trout from the Puyallup Core Area and bull trout from this core area are expected to be well distributed throughout the action area looking for quality foraging areas. The USFWS expects up to 275 adult or subadult bull trout maybe distributed throughout the action area at any time.

Factors Affecting the Bull Trout in Puget Sound Geographic Region

Development impacts in tributaries to the Puget Sound have resulted in significant habitat loss for anadromous salmonids, including bull trout. Floodplain function has been severely altered by constrictions resulting from diking, development encroachment, and transportation corridors.

The nearshore environment provides important habitat for bull trout prey species, including spawning surf smelt, herring, and juvenile salmon. Significant portions of nearshore habitat in the Puget Sound have been altered by bulkheads placed to protect various developments (Table 2 and 3). Approximately 29 percent of shoreline in Puget Sound is armored (approx. 725 linear miles) and approximately 405 miles are those armoring residential properties (Habitat Strategic Initiative 2021; MacLennan et al 2017).

Due to their large populations, individual bull trout from the Chilliwack, Upper Skagit, and Lower Skagit are vital to the persistence of bull trout in the Coastal Recovery Unit, especially those that demonstrate an anadromous component. Currently, overwater structures, stormwater runoff, and non-point source pollution from residential development and urbanization are factors contributing to the decline of bull trout and bull trout habitat within the action area (USFWS 2015b). To ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout in the action area, restoration of impaired nearshore marine habitat, remediation of contaminated sites in the nearshore environments, reduction/minimization of impacts from development and transportation corridors along marine shorelines, and restoration or recreation of intertidal foraging habitats is necessary (USFWS 2015b).

The threat of ongoing development and urbanization that degrade or eliminate nearshore marine and estuarine habitats and that results in continued declines of nearshore forage species and juvenile salmon has impacted the resiliency of anadromous bull trout in Puget Sound. The full magnitude of impact is unknown given the opportunistic foraging by bull trout and their ability to alter foraging based on available prey species.

10.3.8 Olympic Peninsula Geographic Region

The Olympic Peninsula geographic region contains six core areas, where three are located within the action area. The Dungeness River and Skokomish River were identified as having small population sizes (USFWS 2015a, p. A-27). The Quinault River core area, outside of the action area, was identified as the one stronghold in this geographic region (USFWS 2015a, p. A-3). Abundance information is lacking for many of the core areas. Scattered surveys including redd counts, bull trout observations, snorkel surveys, etc. were conducted in many of the core areas within the Olympic Peninsula geographic region. However, long-term surveys or surveys have not occurred since 2010 due to lack of funding, difficulty accessing spawning areas, and challenges of surveying in mountainous roadless areas.

In the Olympic Peninsula geographic region, angling or harvest of bull trout was identified as the primary threat in four bull trout core areas: Hoh, Queets, Quinault, and Skokomish River core areas (USFWS 2015a, pp. A-17 to A-20). Reduced prey abundance is also a threat. Transportation networks, and both improved and unimproved forest roads, have caused significant impacts in this region. Many roads within this region are adjacent to streams and have numerous stream crossings that have direct impacts to the stream banks, habitat, and channels as the roads periodically fail. Road maintenance results in a continuous supply of sediments that reduces spawning habitat. Within shared FMO, residential development and urbanization is a primary threat along the Strait of Juan de Fuca. Along the Pacific Coast and tributaries, legacy forest management is a primary threat (USFWS 2015a, p. A-21).

Connectivity between core areas in this geographic region is naturally low due to the geographic distance between them: one core area is located in Hood Canal, two are in the Strait of Juan de Fuca, and three are along the Washington Coast (USFWS 2015a, p. A-17). However, bull trout can migrate between nearby core areas, or can migrate to non-core areas or FMO habitat (Humptulips, Chehalis, Moclips, Raft, etc.). The nearshore marine waters of Hood Canal provide FMO habitat for anadromous bull trout. Bull trout originating from the Dungeness or other, north Puget Sound core areas may occasionally occur within northern portions of Hood Canal. Removal of the Elwha River dams provides unimpeded passage for bull trout migration throughout the core area from spawning areas in the headwaters to the marine water in the Strait of Juan de Fuca. The Straits of Juan de Fuca FMO includes nearshore waters between the northwestern tip of the Olympic Peninsula (Cape Flattery) east to Point Wilson at Port Townsend, and several small independent tributaries flowing into this area.

The Dungeness and Elwha watersheds are the only bull trout core areas connected to the Strait of Juan de Fuca FMO. There are a number of small independent drainages to the strait, some of which originate in Olympic National Park. The frequency of bull trout use of these tributaries is poorly understood. Bull trout have been documented in the Strait of Juan de Fuca drainages of Bell, Siebert, Morse, and Ennis Creeks (Mongillo 1993; WDFW 1998; Freudenthal 2001).

As with the Puget Sound geographic area, the USFWS assumes the number of individual bull trout entering marine waters will be similar in the Olympic Peninsula geographic area. The USFWS assumes variable levels of spawning migrations occur across the action area, and therefore during the marine residency period (March through July), up to 55 percent of the anadromous adult and subadult migratory individuals from each core area could enter Puget Sound. During the non-marine residence period (August through March), the USFWS assumes fewer than 25 percent of the anadromous bull trout would remain in marine areas.

10.3.9 Skokomish Core Area

The Skokomish Core Area comprises the South Fork Skokomish River, North Fork Skokomish River (above and below the Cushman Dams), Vance Creek, and their tributaries. Mainstem habitat in the watershed provides important foraging, migration, and overwintering habitat for sub-adult and adult bull trout. The Skokomish River core area is the only identified core area with access to Hood Canal. Fluvial, adfluvial, and resident life history forms of bull trout occur in the Skokomish core area. It is believed that the anadromous life history form was present until the 1980s (USFWS 2010b, pp. 59-61). Currently, the Skokomish core area population does not appear to have an anadromous component, based on otolith chemistry data (Larry Ogg, USFS, cited in Correa 2003, p. 49) and surveys in the estuary and lower river (Peters et al. 2011, pp. 157-163). However, low numbers of smolt-sized bull trout are often captured in a smolt trap near the river’s mouth. These observations, combined with the habitat restoration and salmon and steelhead recovery efforts within the Skokomish basin and nearby Hood Canal, suggest that an anadromous component may reestablish in the future.

As with other Olympic Peninsula Core Areas, there are limited data on adult abundance of Skokomish Core Area bull trout. There are two local populations in the Skokomish Core Area: North Fork Skokomish and South Fork Skokomish. Peters et al. (2011, p. 161) estimated 115

(95 percent CI; 42-207) adult bull trout were present in the anadromous reaches of the South Fork Skokomish system during the summer of 2008. Combined with Olympia National Park data for the isolated (above Cushman Dam No. 1) North Fork Skokomish River, Peters et al. (2011, p. 161) estimated approximately 419 adult bull trout in the Skokomish watershed in 2008. Combined both local populations are estimated at less than 500 breeding adults (Peters et al 2011).

There are six primary threats to bull trout in the Skokomish core area (USFWS 2015a, p. A-19 to A-20): Legacy Forest Management and Roads, Flood Control, Fish Passage Issues, Angling or Harvest, Small Population Size, and Reduced Preybase. Given the passage barriers in the North Fork Skokomish from Cushman Dam, combined with low numbers of anadromy and few observations of individuals in smolt traps, the USFWS expects fewer than 55 bull trout may be present in the action area. These individuals are unlikely to venture outside of Hood Canal.

10.3.10 Dungeness Core Area

The Dungeness River core area comprises the Dungeness and Gray Wolf Rivers, associated tributaries, and estuary. The Dungeness River core area is one of two core areas in the Coastal Recovery Unit that are connected to the Strait of Juan de Fuca. The anadromous and fluvial life-history forms occur in the Dungeness River core area (USFWS 2004, pp. 60-61; Ogg et al. 2008). Anadromy was observed in 27 percent of 48 radio tagged bull trout in 2003 and 2004 (Ogg et al. 2008, p. 19). Of 79 char known to have been sampled from anadromous reaches of the Dungeness River watershed, all but one were positively identified as bull trout via genetic analysis (Spruell and Maxwell 2002; Spruell 2006; DeHaan et al. 2011).

Two local populations - the Dungeness River and the Gray Wolf River - are recognized within the Dungeness River core area (USFWS 2004, p. 61; USFWS 2015a, p. A-150). Screw trap data in the Dungeness River core area between 2007 and 2019 show that the highest number of juvenile bull trout caught was 147 in 2014, but the number has decreased since, with only 2 juvenile bull trout caught in 2019 (WDFW 2011-2021). Although, the 5-year mean shows a relatively stable number of bull trout caught in the screw trap, large numbers caught in 2008 and 2014 indicate a decreasing trend. The USFWS 2008 Five Year Review categorized the Dungeness River core area as having 50 to 250 individuals (USFWS 2008a, p. 35).

The 2015 Bull Trout Recovery Plan identifies four primary threats to bull trout in the Dungeness River core area (USFWS 2015a, p. A-17): Flood Control, Altered Flows, Small Population Size and reduced Prey Base. In addition, bull trout are highly susceptible to incidental capture and mortality associated with fisheries directed at hatchery-origin coho and steelhead in the anadromous reaches of the Dungeness River watershed and Dungeness Bay.

Adult Dungeness bull trout outmigrate from the river into marine waters primarily from May through August (Ogg et al. 2008, p. 2), which is several months later than other western Washington populations (Brenkman and Corbett 2005, pp. 1078-1079; Goetz et al. 2007, p. 18; Hayes et al. 2011, p. 394). Assuming Dungeness River bull trout exhibit similar marine residency times as these other populations, their return through Dungeness Bay to the river mouth would occur from July through October, exposing the later returners to capture in the coho fisheries. Residential and urban developments along the shore that include intertidal filling, bank armoring, and shoreline modifications have caused the loss of extensive eelgrass meadows in the nearshore. The USFWS anticipates up to 110 adult and subadult bull trout may be broadly distributed in the Strait of Juan de Fuca at any time.

10.3.11 Elwha Core Area

The Elwha River core area, part of the Coastal Recovery Unit, includes the Elwha River, its tributaries, and the estuary that drain to the Strait of Juan de Fuca. Anadromous, fluvial, and resident life-history forms are all present within the Elwha River core area. With the removal of the Elwha River dams and resulting elimination of the two reservoirs (Lakes Mills and Aldwell), the adfluvial life-history form is no longer possible (Crain and Brenkman 2010, p. 16; DeHaan et al. 2011, p. 472).

Two local populations and one potential local population are recognized within the Elwha River core area (USFWS 2015a, p. A-150). Current information on bull trout abundance is lacking but is assumed to be less than 500 individuals. Bull trout abundance was expected to increase in the Elwha River after removal of two dams that blocked passage and recent evidence suggests this is occurring (Duda et al 2021 p.1). The removal of the dams on the Elwha River has provided connectivity between the local populations within the Elwha River core area and with marine areas. This increased connectivity has resulted in bull trout from the lower river migrating to the headwaters (Geffre et al. 2017) through several canyons that previously inhibited bull trout migration (Corbett and Brenkman 2012). In addition, the connectivity has apparently resulted in the resumption of anadromous life history patterns by Elwha River bull trout (Quinn et al. 2017).

The 2015 Bull Trout Recovery Plan identifies four primary threats to bull trout in the Dungeness River core area (USFWS 2015a, p. A-18): Fish Passage Issues, Instream Flows, Reduced Prey Base and Competition and hybridization by nonnative brook trout. Removal of the two dams in the Elwha River has addressed the primary concerns related to fish passage and instream flows since completion of the recovery plan. Impacts from residential and urban development occur mainly in the lower Elwha River and dike construction have constricted the channel and severely affected nearshore and estuary habitat and processes. The USFWS anticipates up to 275 adult and subadult bull trout may be broadly distributed in the Strait of Juan de Fuca at any time. Given recovery and increasing populations in the Elwha basin since removal of the dams, we expect that the total number of individuals within the action area will increase over time.

Factors Affecting the Bull Trout in Olympic Peninsula Geographic Region

As with the Puget Sound geographic region, development in tributaries of the Olympic Peninsula geographic area have resulted in some habitat loss. However, the magnitude of impact is much lower than in Puget Sound. The majority of development impacts area occurring in areas of residential and urban development near Port Townsend, Port Angeles, Sequim, and along Hood Canal. Other impacts from timber harvest in the uplands likely has had some impact on tributary habitat as well. The majority of bull trout habitat, particularly spawning and rearing areas, occur in protected forestlands, wilderness areas or on national park lands. Therefore, few threats to habitat occur within the spawning and rearing areas for these populations. In the developed areas, impacts from stormwater runoff, agriculture, timber harvest, and floodplain constriction likely occur.

Given the health of the watersheds, the largest impact to anadromous populations in the Olympic Peninsula occur within the marine waters. Overwater structure and shoreline armoring that limit forage fish habitat, incidental catch of bull trout during fishing operations, and development in the areas around Port Angeles, Port Townsend, Sequim, and Hood Canal will continue to impact forage resources for bull trout and their prey. Recent improvements in herring biomass in Hood Canal and improved estuary habitat at the Elwha River are increasing forage habitat for bull trout. Over time, the restoration actions in Hood Canal and the Elwha will increase the resiliency and the populations in the Olympic Peninsula geographic area.

10.3.12 Summary of Bull Trout in Action Area

Bull trout individuals in the action area originate from as many as nine Core Areas, each comprising of several local populations. Telemetry studies indicate that up to 55 percent of the adult anadromous populations may enter the action area throughout the year, with most downstream migrations occurring from spawning areas to the marine environment in the late fall through spring. In summer and early fall, bull trout return to freshwater tributaries to spawn (generally, from late August through November, and into December). Habitat impacts from passage barriers in tributaries and urban development have altered the habitat available for bull trout and their forage across the action area. However, habitat restoration actions such as dam removals and passage improvement project as well as riparian and estuary restoration have begun to show improvements to some factors. Bull trout population numbers are variable as a result of conditions within tributaries and in the marine environment. Table 5 summarizes the population status and expected number of bull trout in the action area.

Table 5. Summary of bull trout populations and use of the SSNP Action Area (AA).

Core Areas	**Number of Local Populations**	**Core Area Trend[1]** (Declining/ Stable)	**Estimated Adult Breeding Population**	**Presence in AA**	**Expected # individuals in AA between March and July**	**Expected # individuals in AA August through March**
Chilliwack	10	Stable	>1000	Unknown distribution within US waters, but presumed present in lower numbers within the AA	200	40
Nooksack	10	Stable	501 – 1000	Known use of AA, documented as far south as Swinomish Channel, broad distribution in North PS	550	110

Core Areas	**Number of Local Populations**	**Core Area Trend**[1] (Declining/ Stable)	**Estimated Adult Breeding Population**	**Presence in AA**	**Expected # individuals in AA between March and July**	**Expected # individuals in AA August through March**
Lower Skagit	20	Declining	>1000	Known use of AA, broad distribution in North PS	1000	200
Upper Skagit	15	Stable	>1000	Unlikely use of the AA due to passage barriers. Populations above dams.	0	0
Stillaguamish	3	Declining	50 - 100	Most of population uses AA, broad distribution in North PS	55	11
Snohomish/ Skykomish	4	Declining	501 – 1000	Most of population uses AA, broadly distributed in north and Central Puget Sound	550	110
Puyallup	4	Stable	101-500	Known use of the AA, Broad distribution in South Puget Sound	275	55
Chester Morse	4	Stable	101-500	Unlikely use of the AA. Isolated in Chester Morse Reservoir	0	0
Skokomish	2	Stable	101-500	Low likelihood of use due to barriers, small numbers of smolts observed in lower river and estuary, likely confined to Hood Canal	55	11
Dungeness	2	Stable	101-500	Most of population uses AA, broad distribution in Strait of Juan de Fuca	110	22
Elwha	2	Stable	101-500	Most of population uses AA, broad distribution in Strait of Juan de Fuca	275+	55

[1] Declining: Population numbers or redd counts are reducing/declining in recent years; Stable: No indication of population change; Increasing: Population numbers or redd counts have been improving/increasing in recent years.

10.3.13 Factors Responsible for the Condition of Critical Habitat

In nearshore marine areas, the inshore extent of critical habitat is the mean higher high-water line, including the uppermost reach of the saltwater wedge within tidally influenced, freshwater heads of estuaries. Critical habitat extends offshore to a depth of 10 meters (33 ft) relative to the mean lower low water line (75 FR 63935; October 18, 2010).

Of the 32 critical habitat units for designated critical habitat of bull trout, only two are found within the action area and correspond with the geographic area described for bull trout. The Olympic Peninsula Critical Habitat Unit (CHU #1) includes tributaries and marine areas of Hood Canal, Strait of Juan de Fuca, and the outer coast of Washington north of Willapa Bay (USFWS 2010a). There were 465.2 miles of stream, 328.8 miles of shoreline, and 7,572 acres of lakes and reservoirs designated in the Olympic Peninsula CHU (USFWS 2010a). The Puget Sound CHU (CHU#2) includes tributaries and marine areas within the U.S. portions of Puget Sound and encompasses 1,143.5 miles of streams, 425.0 miles of marine shoreline, and 40,181.5 acres of lakes and reservoirs (USFWS 2010a). These areas were identified as key to supporting anadromous populations of bull trout only found within the Salish Sea and outer coast of Washington (USFWS 2010a, b).

Within the action area, the current condition of designated bull trout critical habitat varies considerably. Current conditions reflect natural variability, patterns of disturbance and recovery from both natural and man-made events, and the effects of earlier and concurrent, unrelated activities occurring in the same nearshore environments and watersheds. Natural nearshore habitat complexity is either mildly or moderately impaired throughout much of the action area. The same can be said for the condition of the bull trout prey base. At some locations either or both of these functions may be severely impaired.

The action area includes nearshore marine environments providing five of the nine PCEs of designated bull trout critical habitat (50 FR 63898; October 18, 2010):

(2) *Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.*

> Throughout the action area and into the tributaries, migration habitat for bull trout is affected in various ways. In lower portions of tributaries, there are small dams, culverts, bridges, and weirs that limit or partially block passage and migration of bull trout between foraging areas in the action area and spawning/rearing areas in headwaters of tributaries. Continuous efforts to restore and improve passage conditions are occurring across the Salish Sea.
>
> Within marine and marine influenced areas, migrations are minimally impacted. Overwater structures may dissuade bull trout from certain areas and move around structures. However, there is minimal evidence indicating that overwater structures create impediments to bull trout movements in the Salish Sea. Areas of altered water quality from stormwater discharge, temperature gradients, or other discharges of pollutants may also hinder movements or cause bull trout to temporarily move around certain areas. While impacts of

overwater structures or water quality impairments may result in temporary or slight alterations in bull trout movement or migrations, overall the USFWS considers this PCE to be functioning at risk.

(3) *An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

Nearshore areas of the action area provide valuable foraging for anadromous bull trout that allow adults and subadults to become larger and more fecund. Anadromous bull trout opportunistically forage on invertebrates, forage fish such as herring and sand lance, juvenile salmon, and other small fish. Across the action area, habitat for forage species is degraded from development of overwater, in-water and nearshore structures, activity, and fishing pressure. In addition, the diversity and composition of the forage base has changed over time, with some species declining and others increasing. For example, species like Pacific herring have declined across the action area (Figure 4) as have Chinook salmon populations across the action area (NMFS 2021). However, populations of pink salmon in the region and other forage fish are increasing or remaining stable. Reductions in high-quality forage resources likely have shifted bull trout foraging to other species that may be of less caloric content but are still abundant. Therefore, while diversity and composition of forage species in the action area has changed, the overall availability of forage resources has remained generally consistent for bull trout.

In addition, changes to forage resources are not uniform across the action area. Some areas, such as Hood Canal and the Strait of Juan de Fuca have seen habitat improvement and increases in high value forage species such as herring (Figure 4). Restoration actions such as shoreline improvements and dam removals (Elwha River) have improved the function of this PCE. Therefore, the USFWS considers this PCE to be functioning at risk across the entire action area.

(4) *Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.*

Habitat complexity is variable across the action area. In tributaries, habitat complexity comes from large woody debris recruitment and retention, scour pool formations, undercut banks, boulder diversity and structure, and overhanging vegetation (trees). Levees, floodplain development, bank armoring, and channelization in tributaries have reduced or limited natural sediment and flow processes that create this complexity and provide the habitat diversity for cover and forage needed by bull trout. Restoration activities implemented in the tributaries is beginning to improve conditions is some areas of the action area (i.e., Elwha, Skokomish, Skagit, etc.); however, ongoing urban development continues to impact the lower reaches of many Core Area tributaries and estuaries.

Shoreline development, overwater and in-water structure, and bank armoring create similar impacts to habitat complexity in the nearshore marine environment. These structures reduce sediment transport and distribution, development and health of submerged aquatic vegetation, and alter erosion patterns leaving uniform shoreline conditions and habitat fragmentation. In highly developed areas of central and southern Puget Sound and around cities such as Port Angeles, Bellingham, and Everett, this PCE is highly degraded and not properly functioning. In other areas, where shorelines are less developed or targeted restoration actions are or have occurred (i.e., Nisqually delta), this PCE is likely functioning at risk. Overall, habitat complexity in the action area is not properly functioning.

(5) *Water temperatures ranging from 2 °C to 15 °C (36 °F to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; stream flow; and local groundwater influence.*

Within the action area, water temperatures are not likely limiting for bull trout. Seasonally, elevated temperatures are documented in shallow embayments, estuaries, and lower tributaries. These elevated temperatures primarily occur when bull trout are not actively using the habitat and have returned to stream headwaters. Therefore, overall this PCE is considered fully functioning.

(8) *Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.*

Water quantity in the action area is not limiting for bull trout. However, within the action area, water quality conditions are variable and degraded conditions exist. Areas of stormwater and pollutant discharge occur in urban areas resulting in Ecology 303(d) listed concerns. In addition, hypoxic events are seasonally documented in Hood Canal and other shallow embayments across the action area. Water quality conditions in tributaries are also degraded in many of the lower reaches of Core Area tributaries with contaminants including Polychlorinated Biphenyls (PCBs), Polycyclic Aromatic Hydrocarbons (PAHs), low dissolved oxygen and pH. Therefore, the USFWS considers this PCE to be functioning at risk across the entire action area.

10.3.14 Conservation Role of the action area

Marine and estuary areas of the action area are essential for providing the anadromous life history of bull trout (USFWS 2010a; b). The primary function of the habitat in the action area is for foraging and overwintering bull trout to grow larger, more fecund, and provide connected resiliency between Core Areas across the Puget Sound and Olympic Peninsula geographic areas of the Coastal Recovery Unit. In most cases, PCE's are functioning in the capacity needed to provide for the conservation of bull trout, but in a degraded condition. However, habitat complexity that provides cover and shelter for bull trout is not functioning in much of the action area. In estuarine and nearshore habitats, restoration projects improving nearshore habitat conditions for forage fish; removing or modifying structures such as shoreline armoring, bulkheads, dikes, and tide gates; contaminant remediation; or, restoring eelgrass or kelp beds are occurring and further improve the function of critical habitat in the action area (USFWS 2015a, p. 28).

Connectivity between spawning and rearing habitat and FMO habitat within the action area for bull trout to move freely and with minimal risk is necessary for the expression of anadromous life history patterns. In core areas where multiple local populations exist, interaction among local populations through movement of migratory individuals is critical to maintaining genetic diversity and recolonizing local populations that become extirpated. Thus, when connectivity with FMO habitat is impaired or blocked, bull trout populations tend to become restricted to isolated local populations, which may have low genetic diversity, are vulnerable to extirpation, and cannot be readily recolonized. Barriers to connectivity may consist of natural physical features such as waterfalls; river reaches that create mortality risks or prevent movement of adult fish because of entrainment, excessively warm water, or poor water quality; instream structures such as culverts or weirs; or dams (USFWS 2015a, p. 27). Within the action area, FMO is generally unimpeded and provides connectivity between Core Areas.

In estuarine and nearshore habitats, projects may include improving nearshore habitat conditions for forage fish; removing or modifying structures such as shoreline armoring, bulkheads, dikes, and tide gates; contaminant remediation; or, restoring eelgrass or kelp beds (USFWS 2015a, p. 28).

Bull trout are opportunistic feeders, with food habits primarily a function of size and life history strategy (USFWS 2015a). Anadromous bull trout enter marine waters seasonally to prey on forage fish species (herring, smelt, sand lance) as well as juvenile salmon and invertebrates. These forage species depend on the nearshore marine environment and overall marine productivity to maintain their life histories, distribution and abundance. These locations are very vulnerable to destruction or modification through human activities, especially urban and rural development, and existing degraded conditions reduce the ability of the action area to fully support the conservation value of critical habitat for bull trout.

10.4 Marbled Murrelet

10.4.1 Marbled Murrelet Population and Distribution in the Action Area

The marbled murrelet forages in the nearshore marine environment and flies inland to nest in mature conifers. Most breeding activity occurs May through July. Feeding of nestlings occurs between May and September. During the nestling period, adults commute from ocean feeding areas to inland nest sites. Marked changes in density and distribution begin in August and continue through September when the last chick will have fledged. Marbled murrelets undergo a month long “pre-alternate molt” approximately four to six weeks before the beginning of breeding, and a one to two month “pre-basic molt” following the breeding season during which they are flightless in the marine environment (Naslund 1993, p. 598). Molting and breeding activities are both energetically costly (Becker and Beissinger 2006, p. 477; Carter and Stein 1995, p. 102). During the fall and winter months between the pre-basic molt and the breeding season, marbled murrelets are foraging and sheltering from storms.

The Recovery Plan for the Marbled Murrelet identifies 6 broad "Marbled Murrelet Conservation Zones" across its range. The delineation of the zones was based on current population and habitat distributions, threats, and geopolitical boundaries. These Conservation Zones were assigned recovery goals and objectives (USFWS 1997, p. 114) and, on that basis, they function as recovery units. Their assigned conservation role is to support persistent populations of the marbled murrelet across its range. (Figure 6). The action area encompasses marine and some upland (8,900 ft inland) portions of Zone 1, which includes all of Puget Sound and most waters of the Strait of Juan de Fuca. Zone 1 extends inland a distance of 50 miles and includes the northern and eastern section of the Olympic Peninsula.

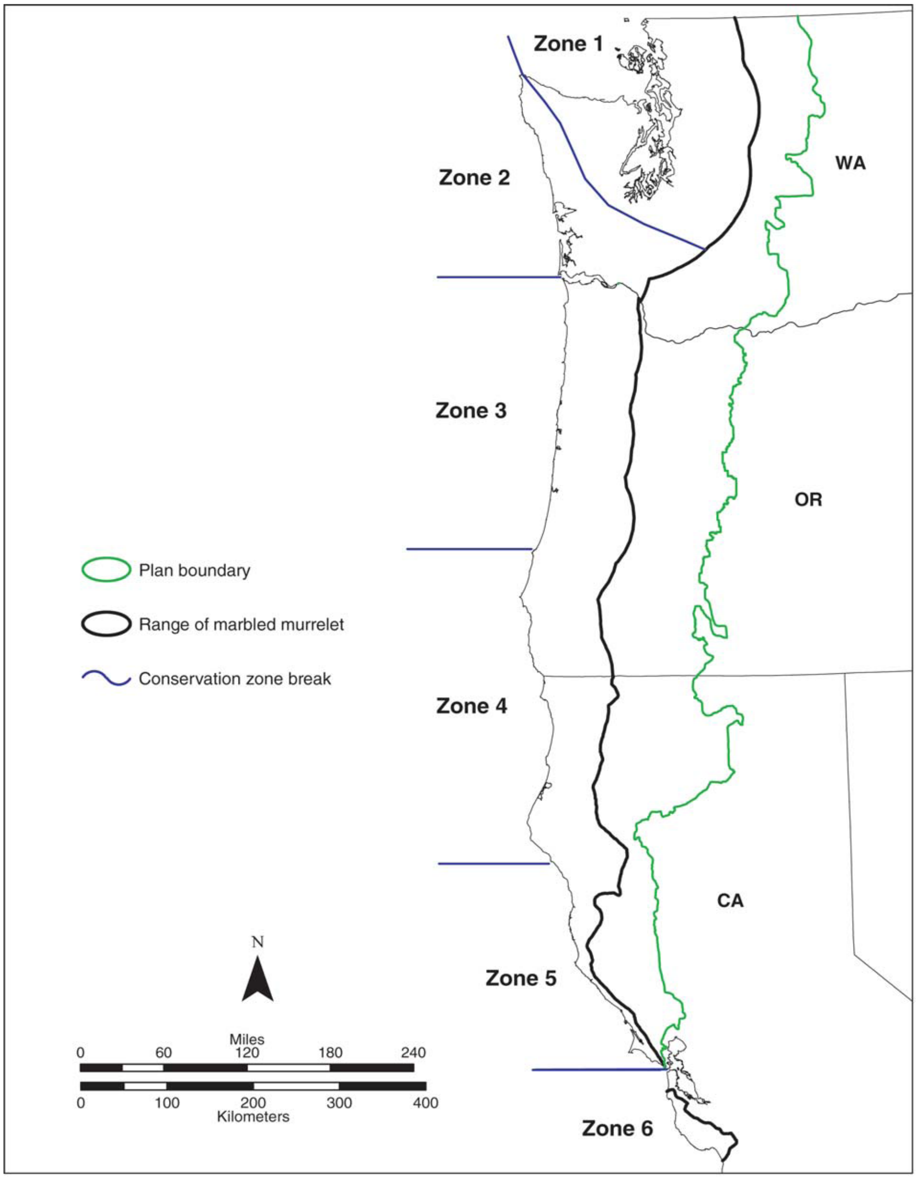
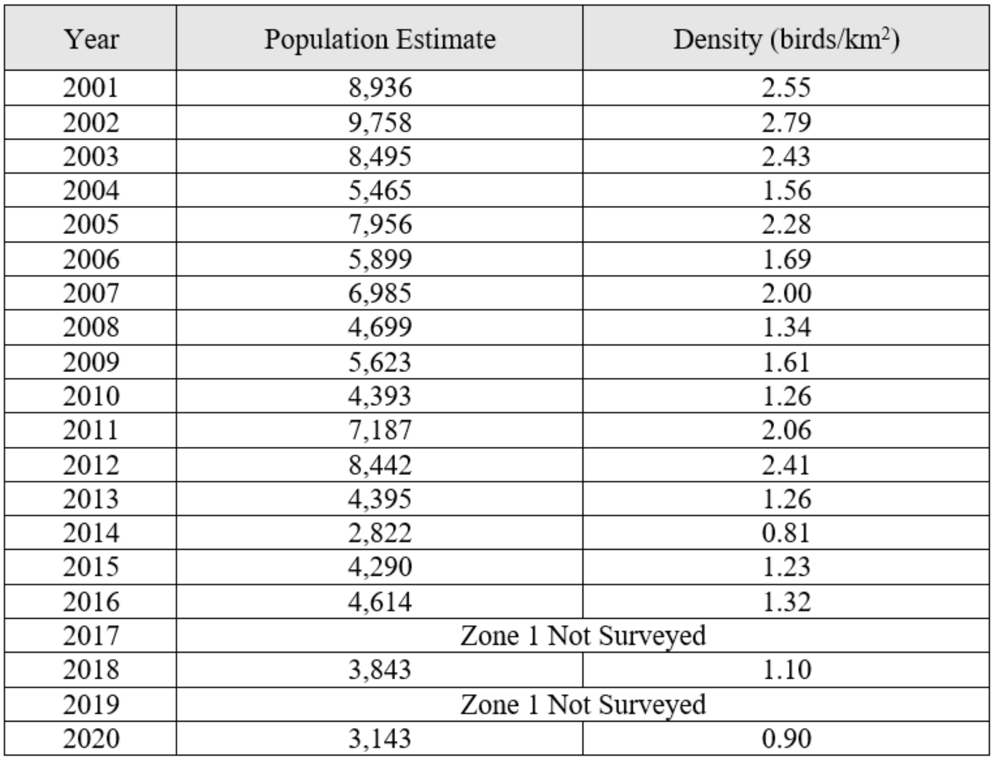


Figure 6. Marbled Murrelet Conservation Zones
(USFWS 1997, p. 114)

The action area broadly includes the marine waters and inland up to 8,900 ft from the shoreline of Puget Sound, Hood Canal and the Strait of Juan de Fuca. Due to the nearshore marine nature of the proposed action, very small areas of suitable nesting habitat may be found within or adjacent to project areas.

The USFWS considers the Northwest Forest Plan's Effectiveness Monitoring Program (NWFPEM) to be the best available information on the population status and trends of marbled murrelets in Puget Sound. Surveys conducted as part of the NWFPEM for marbled murrelets resulted in a population estimate of 3,143 marbled murrelets (95 percent confidence interval [CI] of 2,030-4,585) and a density estimate of 0.90 marbled murrelets per km^2 in Conservation Zone 1 in 2020, the last year for which an estimate is available (McIver et al. 2021, p. 16; Table 6). Since 2001, the NWFPEM-estimated population size for Conservation Zone 1 has ranged from a low of 2,801 marbled murrelets in 2014 to a high of 9,758 in 2002 (McIver et al. 2021, pp. 11-17; Table 6). Between 2001 and 2020, the estimated average marbled murrelet density in Conservation Zone 1 has ranged from 0.81 to 2.43 marbled murrelets per km^2 (McIver et al. 2021, pp. 11-17; Figure 7). Overall, the population in Conservation Zone 1 has been generally declining over the history of Northwest Forest Plan effectiveness monitoring, decreasing at around 5.0 percent per year (McIver et al. 2021, p. 20).

Table 6. Marbled murrelet population estimates and density (birds/km^2) in Conservation Zone 1 between 2001 and 2020.



Year	Population Estimate	Density (birds/km^2)
2001	8,936	2.55
2002	9,758	2.79
2003	8,495	2.43
2004	5,465	1.56
2005	7,956	2.28
2006	5,899	1.69
2007	6,985	2.00
2008	4,699	1.34
2009	5,623	1.61
2010	4,393	1.26
2011	7,187	2.06
2012	8,442	2.41
2013	4,395	1.26
2014	2,822	0.81
2015	4,290	1.23
2016	4,614	1.32
2017	Zone 1 Not Surveyed	
2018	3,843	1.10
2019	Zone 1 Not Surveyed	
2020	3,143	0.90

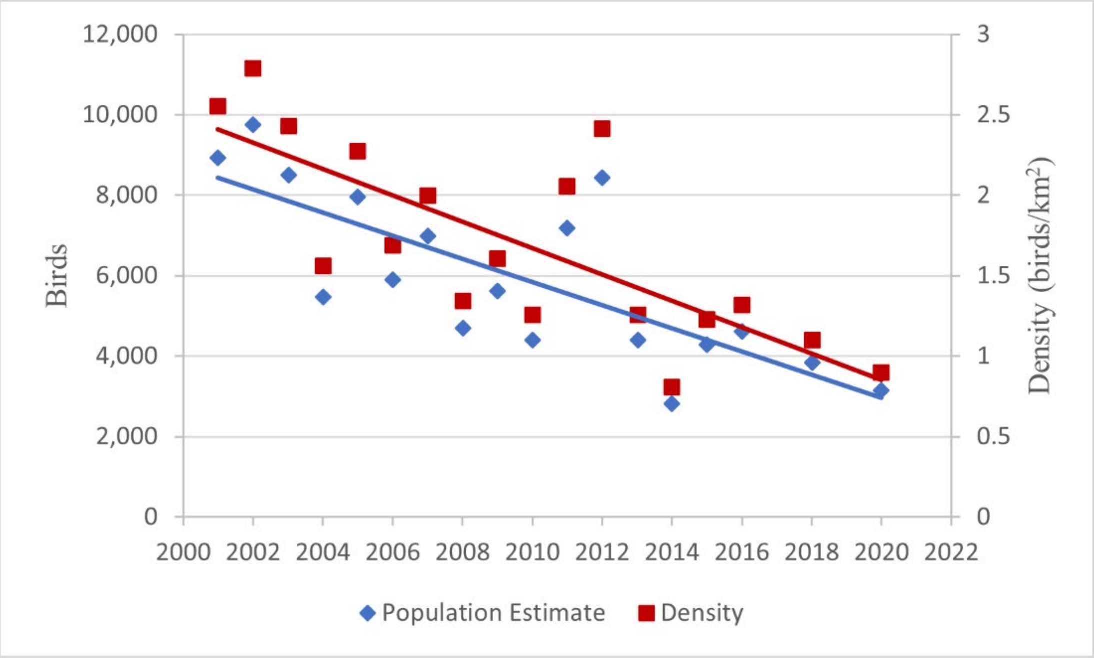


Figure 7. NWFPEM marbled murrelet population estimates and densities for Conservation Zone 1.
(McIver et al. 2021, pp. 11-17)

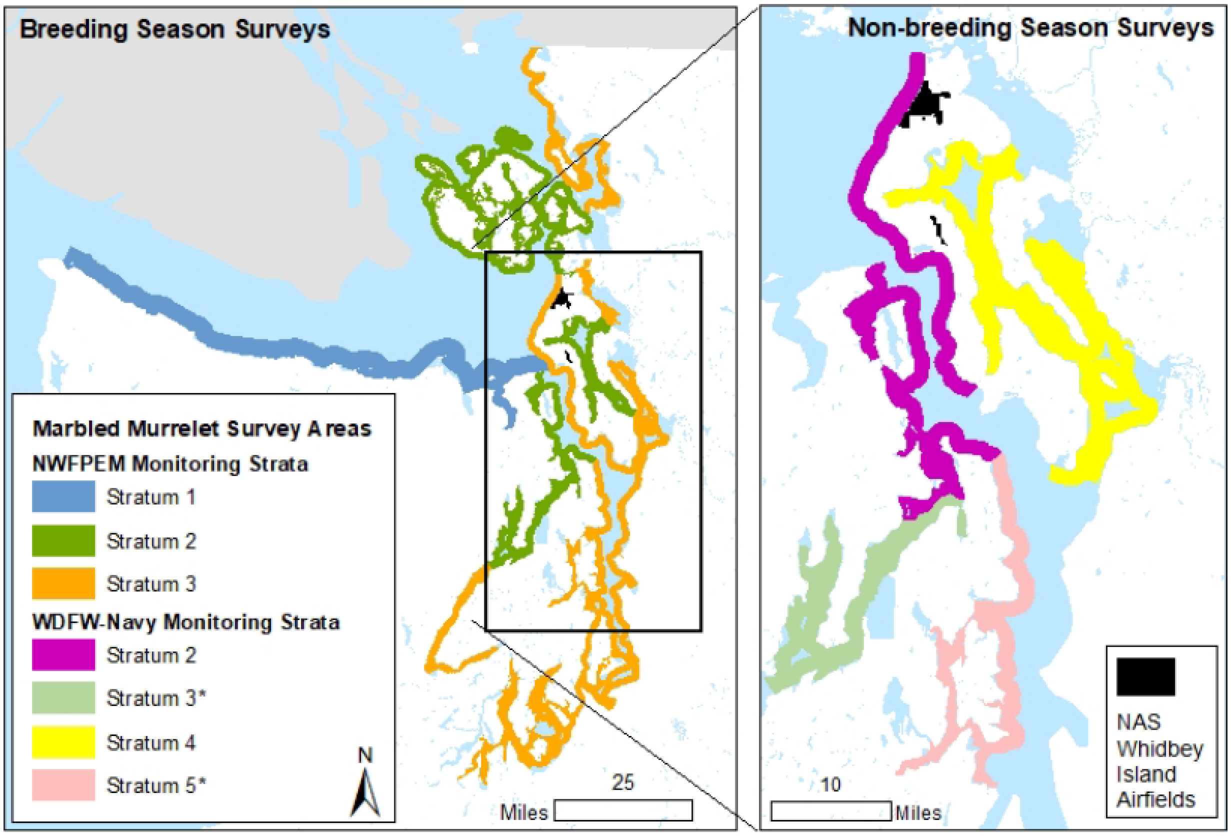


Figure 8. Marbled murrelet at-sea survey strata within Conservation Zone.

Marbled murrelet population density is not uniform throughout Conservation Zone 1. During the breeding season, NWFPEM surveys are conducted in three monitoring areas, or strata (Figure 8). The action area includes NWFPEM Stratum 1, 2, and 3. NWFPEM Stratum 1 is located along the Strait of Juan de Fuca, and almost always has the highest marbled murrelet densities, ranging from 1.26 birds/km^2 in 2014 to 7.21 birds/km^2 in 2002 (Figure 9)(McIver et al. 2021, pp. 11-17). Since 2014, marbled murrelet density in NWFPEM Stratum 1 has averaged 1.88 birds/km^2. NWFPEM Stratum 2, encompassing the San Juan Islands, most of Rosario Strait, the western shore of Admiralty Inlet, northern Hood Canal, and Whidbey Basin, usually has the next highest density, ranging from 0.66 birds/km^2 in 2013 to 2.43 birds/km2 in 2005 (Figure 9) (McIver et al. 2021, pp. 11-17). Since 2014, marbled murrelet density in NWFPEM Stratum 2 has averaged 1.35 birds/km^2. NWFPEM Stratum 3 includes central and southern Puget Sound, southern Hood Canal, the western shore of Whidbey Island, and all other areas along the mainland coast, and generally has lower marbled murrelet densities, ranging from 0.06 birds/km^2 in 2015 to 2.07 birds/km^2 in 2001 (Figure 9)(McIver et al. 2021, pp. 11-17). Since 2014, marbled murrelet density in NWFPEM Stratum 3 has averaged 0.37 birds/km^2.

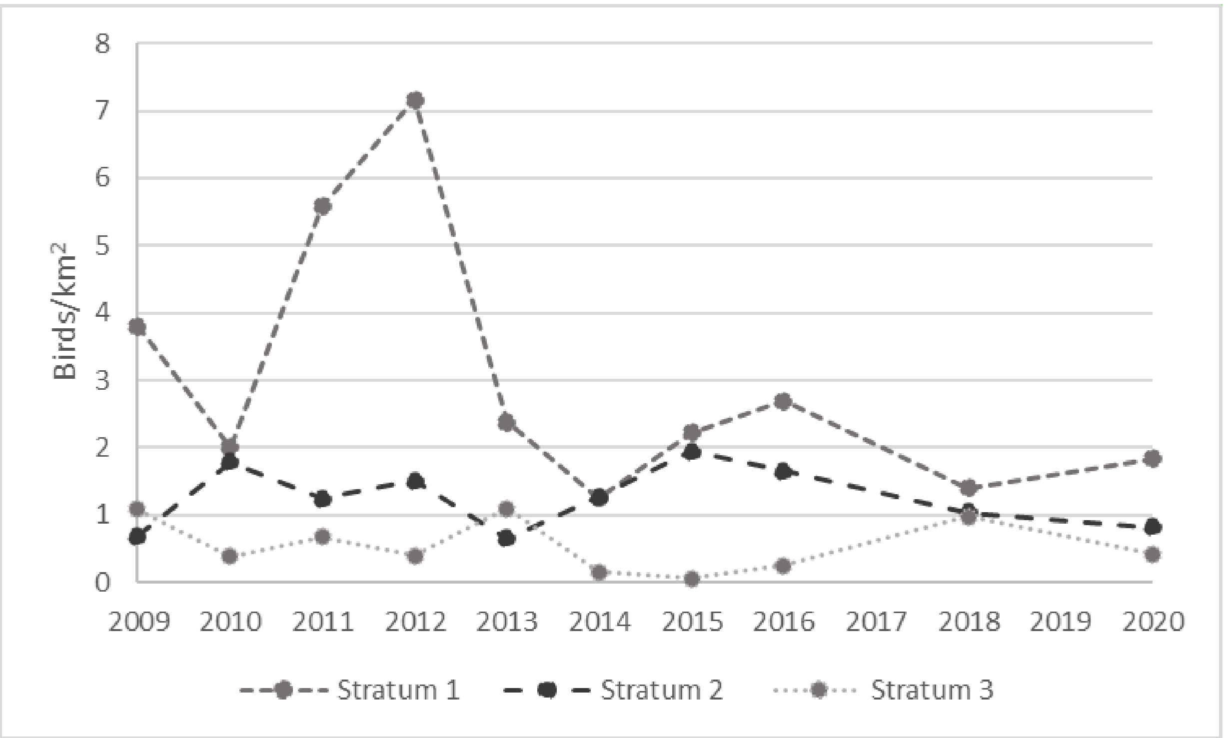


Figure 9. Breeding season marbled murrelet densities (birds/km^2) in NWFPEM strata within 2 or 5 km of shore.

In addition, the action area includes areas offshore of the sampled strata, which extend 5 km (NWFPEM Stratum 1) or 2 km (NWFPEM Strata 2 and 3) from shore. Marbled murrelets are expected to be present in these offshore areas during the breeding season (Lorenz et al. 2016, p. 3), but at a lower density than closer to shore. Based on the preliminary data used to design the NWFPEM surveys, we assume that within the Strait of Juan de Fuca, five percent of marbled murrelets will be located farther than 5 km from shore during daylight hours of the breeding season, and in Strata 2 and 3, densities will be ten times higher within 2 km for shore than they are farther than 2 km from shore (Bentivoglio et al. 2002, p. 22).

Outside of the breeding season, marbled murrelets from British Columbia and from Conservation Zone 2 move into more sheltered waters in Puget Sound and the Strait of Georgia, which contributes to increased numbers of marbled murrelets in Puget Sound in September through April (Burger 1995; Ralph et al. 1995, p. 9; Speich and Wahl 1995, p. 325; Beauchamp et al. 1999, entire). Since 2012, the U.S. Navy (Navy) has funded WDFW to survey areas near Navy installations throughout the non-breeding season (Pearson and Lance 2013, entire; Pearson and Lance 2014, entire; Pearson and Lance 2015, entire; Lance and Pearson 2016, entire; Pearson and Lance 2017, entire; Pearson and Lance 2018, entire). These surveys use the same methods as the NWFPEM surveys, and similarly include areas within 2 km of shore, but the areas are divided into strata differently (Figure 8). WDFW-Navy strata 2, 3, 4, and 5 are within the action area. WDFW-Navy Stratum 2 includes the northernmost end of Hood Canal, Admiralty Inlet, and the western side of Whidbey Island; WDFW-Navy Stratum 3 includes North Hood Canal, Bangor, and Dabob Bay; WDFW-Navy Stratum 4 encompasses most waters to the east of Whidbey Island; and WDFW-Stratum 5 includes the waters in Central Puget Sound from the northern end of the Kitsap Peninsula south to Point Southworth, including Sinclair Inlet and the waters surrounding Bainbridge Island (Pearson and Lance 2018, p. 10).

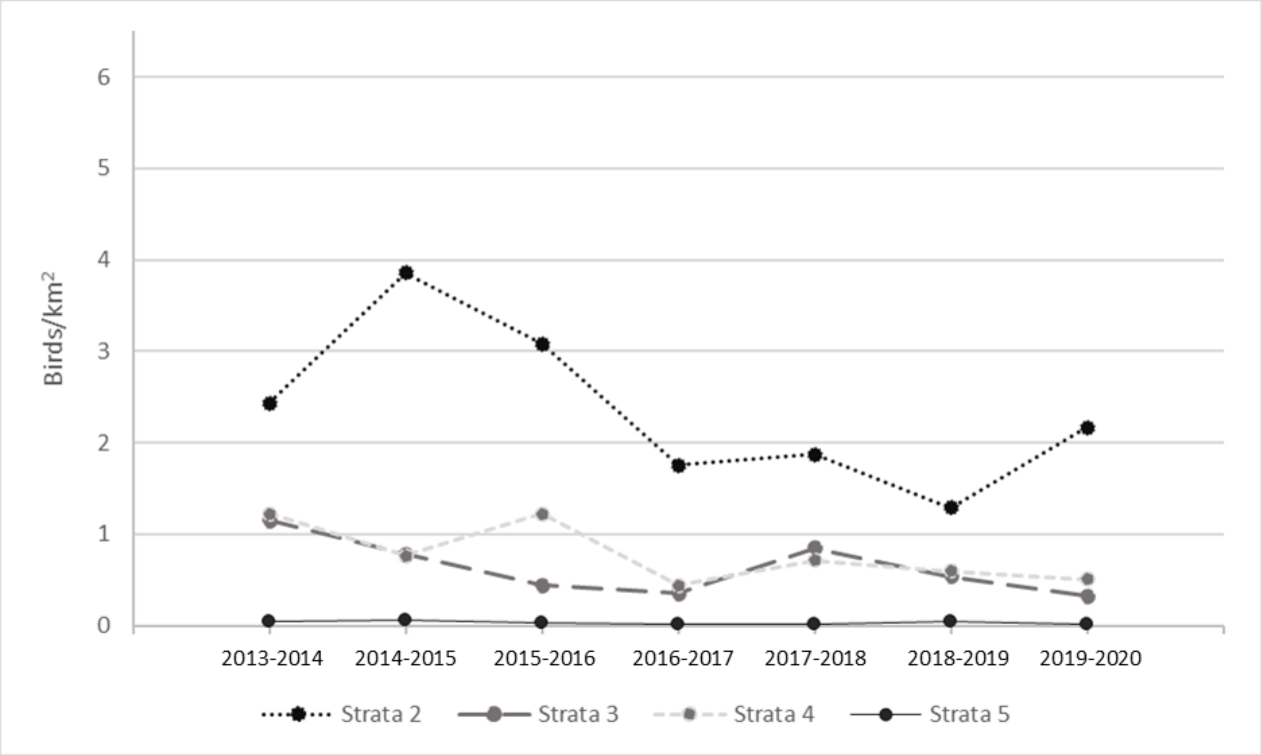


Figure 10. Non-breeding season Marbled murrelet densities (birds/km^2) in Navy-WDFW strata within 2 km of shore.

Over the entire non-breeding season, marbled murrelet densities in WDFW-Navy Stratum 2 have ranged from 1.29 birds/km^2 in fall 2018 through spring 2019 to 3.86 birds/km^2 in fall 2014 through spring 2015; densities in Stratum 3 have ranged from 0.32 birds/km^2 in fall 2019 through winter 2020 to 1.15 birds/km^2 in fall 2013 through spring 2014; densities in Stratum 4 have ranged from 0.44 birds/km^2 in fall 2016 through spring 2017 to 1.22 birds/km^2 in fall 2015 through spring 2016 and fall 2013 through spring 2014; and densities in Stratum 5 have ranged from 0.01 birds/km^2 in fall 2016 through spring 2017 and again in fall 2019 through winter 2020 to 0.06 birds/km^2 in fall 2014 through spring 2015 (Figure 11) (Lance and Pearson 2016, p. 12; Pearson and Lance 2017, p. 12; Pearson and Lance 2018, p. 13; Pearson and Lance 2019, p. 12; Pearson and Lance 2020, p. 14). Since 2015, marbled murrelet densities have averaged 2.03 birds/km^2 in Stratum 2, 0.50 birds/km^2 in Stratum 3, 0.70 birds/km^2 in Stratum 4, and 0.02 birds/km^2 in Stratum 5 (Figure 12). Midwinter aerial survey data indicate that marbled murrelets use offshore areas more heavily during the non-breeding season than during the breeding season, with 28 percent of midwinter marbled murrelet observations recorded farther than 2 km from shore (WDFW 2019b). Note that we do not use aerial survey data to estimate marbled murrelet density directly, because the survey methods are not designed to have good marbled murrelet detectability, but the information is suitable for comparing the number of observations in different parts of the area surveyed.

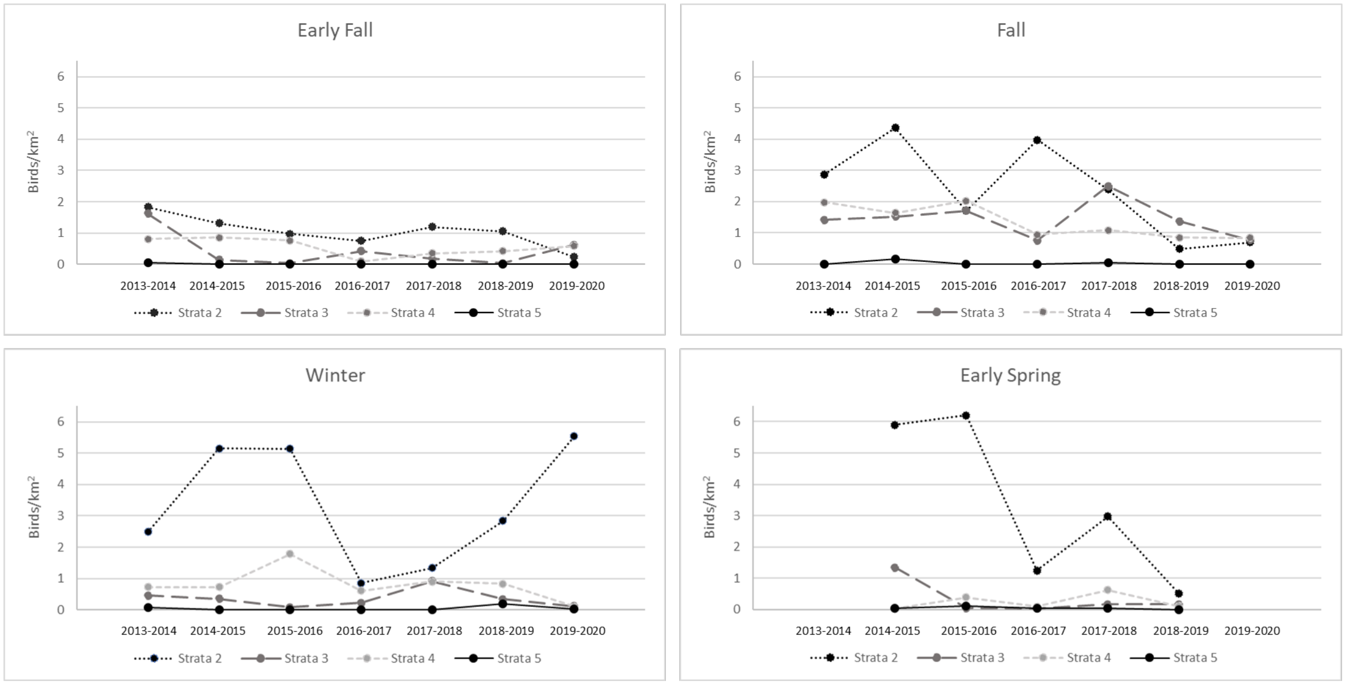


Figure 11. Non-breeding season Marbled murrelet densities (birds/km^2) in Navy-WDFW Strata in early fall, fall, winter, and early spring within 2 km of shore.

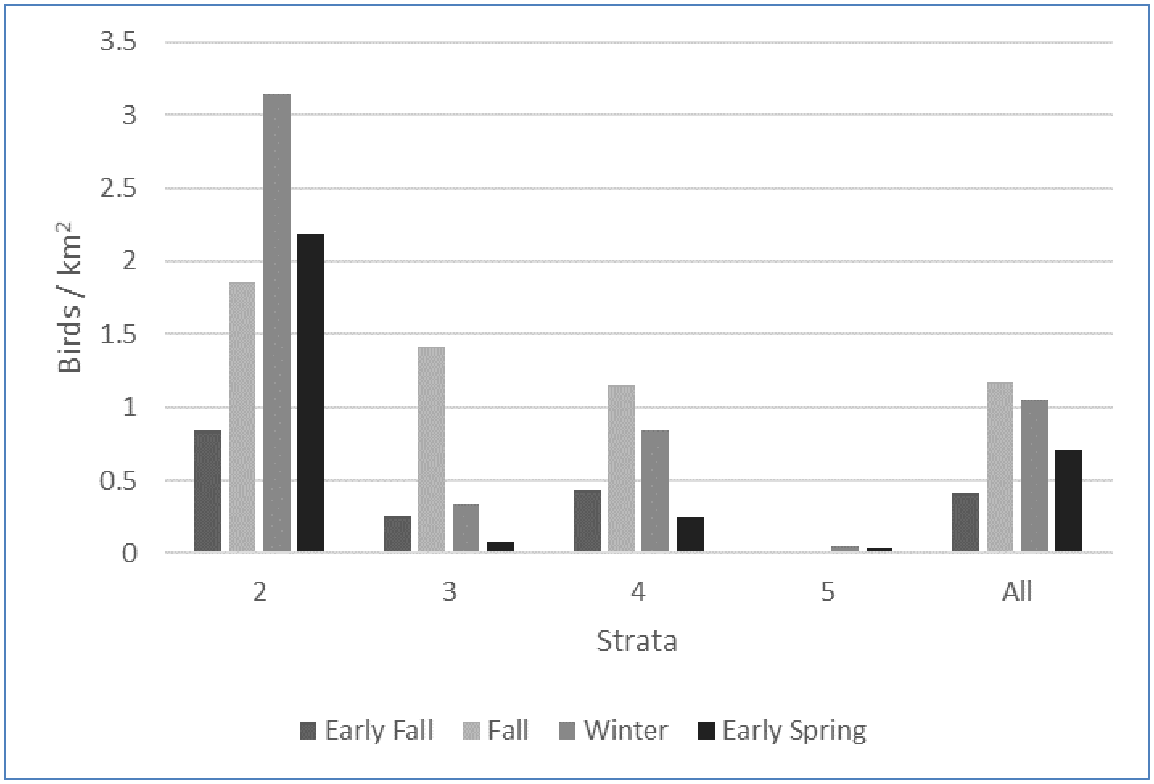


Figure 12. Average non-breeding season Marbled murrelet densities (birds/km^2) in Navy-WDFW Strata in early fall, fall, winter, and early spring within 2 km of shore.

Marbled murrelet distributions change throughout the non-breeding season (Figure 12). Within the Navy-WDFW strata, the density of marbled murrelet is generally highest in stratum 2 independent of season. The average density over 7 years of sampling in stratum 2 has been 0.84 birds/km^2 in early fall (September-November), 1.85 birds/km^2 in fall (November-December), 3.15 birds/km^2 in winter (January-February), and 2.19 birds/km^2 in early spring (March-April) (Figure12). The density in strata 3 increases in fall. The average density in stratum 3 has been 0.26 birds/km^2 in early fall, 1.42 birds/km^2 in fall, 0.33 birds/km^2 in winter, and 0.09 birds/km^2 in early spring. The average density in stratum 4 has been 0.44 birds/km^2 in early fall, 1.15 birds/km^2 in fall, 0.84 birds/km^2 in winter, and 0.25 birds/km^2 in early spring. The density in stratum 5 is typically very low, over 7 years of sampling the highest recorded density was 0.20 birds/km^2 in winter of 2018-2019. The average density in stratum 5 has been 0 birds/km^2 in early fall, 0.01 birds/km^2 in fall, 0.05 birds/km^2 in winter, and 0.04 birds/km^2 in early spring.

Seasonal variations also occur outside of the Navy-WDFW strata. Surveys along the southern shore of the Strait of Juan de Fuca conducted by the WDFW from 1996-1997 (Thompson 1997a) showed an increase in the number and group size of marbled murrelets in August in the eastern Strait of Juan de Fuca, although numbers declined in the western portion of the Strait of Juan de Fuca. Surveys of near-shore waters in the San Juan Islands (Evans and Assoc. Inc. 1999; Ralph et al. 1995) showed a similar increase in abundance in August and September (end of the breeding season when both adults and fledglings are on the water).

Along the western portion of the Strait of Juan de Fuca, marbled murrelet densities are lower in the winter than in the summer, in contrast to the overall increase observed in the action area as a whole (Speich and Wahl 1995, p. 325). In the Marine Ecosystems Analysis (MESA) surveys, a combination of shoreline, boat-based, and aerial surveys conducted in 1978 and 1979, marbled murrelet densities between Neah Bay and Ediz Hook were approximately four times lower (22 percent) in November-March than in April-July (Speich et al. 1992, pp. 57-60; Wahl et al. 1981, pp. 127-131). These changes occur suddenly between July and August. Thompson's data (1999, p. 36) show a sharp decline in marbled murrelet densities between July and August, as do data from boat-based and shore-based surveys by Hamer and Brennan (1994, pp. 21-27). These two datasets indicate that during August, marbled murrelet densities are between 12 percent and 47 percent of the densities measured by the same surveys earlier in the summer.

From Port Angeles eastward, there are local areas that increase in density during transition or fall. East of Dungeness Spit, the waters of the Strait of Juan de Fuca are better protected from storms approaching from the west (Speich and Wahl 1995, p. 325), and this may make them more hospitable to marbled murrelets during stormier seasons. Speich and Wahl (1995, p. 315) reported that within Sequim and Discovery Bays, early fall marbled murrelet densities were eight times higher than densities in the summer, before falling to fall densities between two and three times higher than summer densities. This suggests that there may be a large influx of marbled murrelets through the eastern Strait during the transition season, as birds move in from the outer coast and western Strait, but that only a fraction of these migrants remain in the vicinity of the eastern Strait for the fall.

Marbled murrelet densities in the San Juan Islands increase sharply at the end of July, and reach densities between 1.2 and 18.8 times, and on average 6.5 times, the summer density by late August (Havron 2012, p. 10). We expect marbled murrelet density to continue to increase into the fall, but fall data are limited to one data set showing a 3.3-fold increase (Speich et al. 1992, pp. 57-60; Wahl et al. 1981, pp. 127-131). Aerial and boat-based surveys have identified concentrations of marbled murrelets in the winter months on the east, west, and south sides of Lopez Island, in Orcas Island's East Sound, near Sucia and Matia Islands, around Sinclair Island, and in Guemes Channel.

Even within a survey stratum in a particular season, marbled murrelet densities are consistently concentrated more in some areas than in others. We refer to areas as marbled murrelet hotspots when we have information indicating that marbled murrelets can be found there regularly during the breeding season, the non-breeding season, or throughout the year, at densities higher than other areas in the region. Although marbled murrelet population densities are elevated at these hotspots, we expect that marbled murrelets will at least occasionally be present in all other marine waters of the action area. When particular marine areas are surveyed repeatedly, marbled murrelets are usually observed at least once in each area, though in some areas they are present only sporadically and at low densities (Merizon et al. 1997, p. 19; Speich and Wahl 1995, pp. 315-316).

10.4.2 Factors Responsible for the Condition of Marbled Murrelets in the Action Area

Marbled murrelets were listed as threatened in 1992 due, in large part, to habitat loss and predation in the terrestrial environment, and oil spills and net fisheries entanglement in the marine environment (57 FR 45333-45336 [October 1, 1992]). In 2012, the USFWS convened the marbled murrelet Recovery Implementation Team which concluded that the primary cause of the continued population decline is sustained low recruitment (USFWS 2012c, pp. 7, 10). Sustained low recruitment can be caused by nest failure, low numbers of nesting attempts, and/or low juvenile survival rates due to 1) terrestrial habitat loss, 2) nest predation, 3) changes in marine forage base which reduce prey resources, and 4) cumulative effects of multiple smaller impacts. The USFWS' recent 5-year review (USFWS 2009, pp. 27-67) identified the following additional threats in marine waters:

> Exposure to marine polychlorinated biphenyls in prey;
>
> Changes in prey abundance, availability and quality;
>
> Harmful algal blooms, biotoxins, and dead zones;
>
> Derelict fishing gear that causes entanglement;
>
> Energy development projects (wave, tidal, and on-shore wind energy projects) leading to mortality;
>
> Disturbance, injury, and mortality in the marine environment from exposures to elevated sound levels (caused by pile-driving, underwater detonations, and potentially by vessel traffic); and
>
> Climate change in the Pacific Northwest that may exacerbate many of the marine-related threats, as described above.

Within Washington, marine threats have generally been considered "lower priority" mechanisms of continued marbled murrelet population decline, as compared with terrestrial threats, in part due to a lack of clear information about the marine environment (USFWS 1997, p. 3; USFWS 2012c, pp. 12-15). Recent evidence affirms the importance of both terrestrial nesting habitat and marine foraging habitat, as well as the spatial juxtaposition of the two habitat types. For example, in the action area (but not in the rest of the listed range), the marine human footprint is second only to the quantity of nearby nesting habitat in determining the abundance of marbled murrelets in a given marine location (Falxa and Raphael 2016, pp. 106-110). Throughout the listed range of the marbled murrelet, sustained low recruitment appears to be the primary cause of continuing population declines (USFWS 2012c, p. 3). In the action area, the proportion of adult marbled murrelets attempting to breed is lower than in any other area of the species range where breeding propensity has been measured (Lorenz et al. 2016, p. 11). Since 1993, loss or conversion of nesting habitat in Washington has been higher than in other states. The low breeding propensity of marbled murrelets in Washington is likely due in part to high energetic costs associated with breeding. Nesting adult marbled murrelets in the action area have the longest commuting distances between nest and sea, compared with marbled murrelets that have been studied elsewhere in the species range (Lorenz et al. 2016, p. 12).

Elsewhere in the range, breeding marbled murrelets forage in marine areas close to their nesting habitat, which minimizes energetic costs associated with the commute between nest and sea (Peery et al. 2009, pp. 127, 130). Within the action area, long commuting distances were associated both with the distance of nesting habitat from the coast, and the distance of foraging habitat from the shore (Lorenz et al. 2016, pp. 9, 12-13). This pattern suggests that marbled murrelet breeding attempts are stymied not only by a lack of high-quality coastal nesting habitat, but also by poor or poorly-distributed foraging habitat. In, and adjacent to, the action area, marbled murrelet diet quality has decreased over the last 150 years, with concomitant declines in marbled murrelet productivity. This indicates that diet quality may now be a limiting factor for marbled murrelet populations (Gutowsky et al. 2009, pp. 249-250; Norris et al. 2007, pp. 878-880).

Post-fledging mortality also contributes to sustained low recruitment in the action area. Sources of post-fledging mortality in the marine environment include entanglement in gillnets, purse seines, and derelict gear; oil spills; and impulsive underwater sound from impact pile driving and underwater detonations (USFWS 2012c, p. 13). Very little information is available on the relative contribution of each to the observed population declines.

Numerous state, Tribal, and federal agencies participate in nearshore restoration efforts, which are intended in part to improve and protect habitat for forage fish (WDFW 2015b, p. 6). Between 2002 and 2016, the Northwest Straits Initiative's Derelict Fishing Gear Program removed 5,667 old derelict fishing nets from Puget Sound (NWSF 2016; Wilson, A. in litt. 2016). However, it is unknown whether these efforts will be effective in restoring high-quality marine habitat, much less slow or reverse the decline of the marbled murrelet population in the action area. For example, the prevalence of unpermitted shoreline armoring calls into question reported progress on shoreline restoration (Dunagan 2016; Kinney et al. 2015, pp. 8-13).

10.4.3 Conservation Role of the Action Area

The final Recovery Plan for the marbled murrelet (USFWS 1997, entire) outlines the conservation strategy for the species. Of the primary recovery plan recommendations, the most pertinent to the needs of marbled murrelets within the action area are 1) protect the quality of the marine environment essential for marbled murrelet recovery, and 2) reduce adult and juvenile mortality in the marine environment. Habitat loss, reduced forage resources and degraded conditions have resulted in declining marbled murrelet numbers and low reproductive success. The loss of individuals through death or injury in the marine environment is also a major threat. Net fisheries likely result in considerable mortality to marbled murrelets within Conservation Zone 1 (USFWS 1997, pp. 125, 140).

The action area provides foraging habitat that is essential to marbled murrelet survival and recovery. All waters of Puget Sound and the Strait of Juan de Fuca, including the waters of the San Juan Islands and river mouths, are considered concentration areas of breeding marbled murrelets essential for foraging and loafing (USFWS 1997, p. 135). During the nesting season adult marbled murrelets depend on the action area as foraging habitat for themselves and their nestlings. Marbled murrelets originating from other areas when not breeding may use the action area for foraging throughout the year.

As outlined by the Recovery Plan (USFWS 1997, pp. 112), increasing habitat quantity and quality in the marine environment is essential to the conservation and recovery of the marbled murrelet. Marbled murrelet presence in marine waters is linked with tidal activity (Speich and Wahl 1995, p. 323) and prey availability (which can vary depending on upwelling conditions created by seawater temperature changes and seafloor topography (Becker and Beissinger 2003, pp. 251-252). Marbled murrelets feed on small fish and invertebrates. The main fish prey identified of marbled murrelets in the Puget Sound are Pacific sand lance, Pacific herring, northern anchovy, and surf smelt. Their foraging habits change depending on whether or not they are nesting and provisioning young. When nesting, marbled murrelets tend to forage closer to shore, primarily on larger second-year forage fish allowing them to efficiently feed their young. During non-breeding seasons they disperse and can be found much farther offshore foraging on both small fish and crustaceans. The Recovery Plan recommends protection of nearshore waters extending two kilometers (1.2 miles) from shore, to include estuaries, river mouths, and the ocean floor (USFWS 1997, p. 136).

Pacific sand lance has been documented as the most common prey item in marbled murrelet adult and nestling diet in recent years (USFWS 1997 p. 22, Gutowsky 2009 p. 5). Marbled murrelets incidentally salvaged from gill nets in Washington State (mainly the Strait of Juan de Fuca) had diets that were approximately 86 percent sand lance and 14 percent Pacific herring (Grettenberger et al. 1998). The diet of nestlings has also changed over the last 150 years, the low-trophic level (sand lance) proportion of nestling diet has increased as higher trophic level species (Pacific herring and northern anchovy) populations have declined in the Salish Sea (Gutowsky 2009, p. 5). The recent high proportion of sand lance in nestling diet reflects changes from historical forage fish species composition in the Salish Sea (Greene 2015, p. 167). Between the 1970s and 2010s, historically dominant forage fishes, Pacific herring and surf smelt, declined in 2 sub-basins of the Puget Sound (Central and South Sound) by up to 2 orders of magnitude while sand lance have increased in all sub basins of the Puget Sound (Greene 2009 p. 153). Pacific sand lance have a lower energetic value compared to other prey species. Pacific herring, surf smelt, and northern anchovy provide 3-6 times more energy per fish of the same size (Gutowsky 2009, p. 5). Energy values of prey items fed to nestlings are important, large lipid reserves for fledglings are presumed to enhance post-fledgling survival (USFWS 1997 p. 27). In other alcids, energy provisioning rates have been shown to be positively associated with chick-rearing and overall reproductive success (Gutowsky 2009, p. 5). Nestlings receive an average of three single-fish feedings a day as parents commute between 16 and 145 km between nest and forage location in the Salish Sea, suggesting it is difficult for parents to make up for the loss of high-quality prey by increasing foraging effort (Gutowsky 2009, p. 5, Lorenz et al 2016 p. 314).

Decreasing adult mortality in the marine environment is also a key element of the strategy to conserve and recover the marbled murrelet (USFWS 1997, pp. 112, 122, 125, 140-141, 154). Net fisheries and oil spills are the primary threats known to lead to marbled murrelet mortality in the marine environment, especially in Conservation Zone 1 (USFWS 1997, pp. 125, 140-141, 154). Impulsive underwater sound and harmful algal blooms are additional sources of mortality in the action area (USFWS 2012c, pp. 13-14). Other factors, such as marine pollution, low food availability, and boat traffic, may lead to lower survivorship, injury, or increased energy expenditure by marbled murrelets, but these effects are less clear (USFWS 1997, pp. 155-156; USFWS 2012c, p. 13).

A well-distributed, viable population must be maintained in Conservation Zone 1 to allow for the long-term survival and recovery of the species throughout the listed range (USFWS 1997, p. 115-122). Marbled murrelets spend the majority of their time in the marine environment, so most feeding and mortality events also happen in the marine environment (USFWS 1997, p. 120). Because the action area includes all marine waters of Zone 1, the conservation of marbled murrelets throughout the action area is essential to marbled murrelet conservation within the listed range.

10.5 Previously Consulted-On Federal Actions For Marbled Murrelets And Bull Trout

Within Puget Sound, Hood Canal, and the Strait of Juan de Fuca, USFWS has consulted on the effects of many projects including:

harbor expansions

shoreline armoring

ferry terminal upgrades

aquaculture activities

discharges from wastewater treatment plants

construction of piers, ramps, and floats

bridge, road, pier, and wharf maintenance and upgrades

The adverse effects to marbled murrelets and bull trout associated with most of these projects are similar and focus on the impacts of increased sound pressure levels from pile driving, decreased water quality due to increased turbidity as well as the introduction and circulation of contaminants, and adverse impacts to forage fish populations that may affect individuals of each species. In addition, other large or programmatic consultations have evaluated the overall impacts of actions that may affect both individuals of each species, but also the overall effect on forage resources and their habitat.

The USFWS has recently consulted on the continued Treaty and non-Treaty salmon fisheries throughout Puget Sound, which affect both species directly through net entanglements (USFWS 2017). The USFWS also approved a Habitat Conservation Plan for the Skookumchuck Wind Energy Project (USFWS 2019a). As a result of anticipated effects of the project on individual marbled murrelet and bull trout, the USFWS identified removal of lost or derelict fishing gear in Puget Sound as a measure to mitigate the impacts at inland wind turbines.

The USFWS has also consulted on military training activities. This includes Growler airfield operations at NAS Whidbey Island Complex that have been ongoing since 2012, when the USFWS completed an informal consultation regarding the introduction of the Growler fleet (USFWS 2012b; USFWS 2018a). The USFWS consulted on the Navy's Northwest Training and Testing (NWTT) activities in 2016 (USFWS 2016), 2018 (USFWS 2018b), and 2021 (USFWS 2021). Within the present action area, NWTT activities are expected to affect marbled murrelets directly through the use of helicopters and explosives. The 2016 and 2018 opinions consulted on explosive ordnance disposal training at Crescent Harbor. The 2021 opinion considered both the continuation of adverse effects considered under the 2016 and 2018 opinions, as well as adverse effects from the use of E4 explosives greater than 3 nm from shore in the offshore area of the Washington coastline. In total, NWTT activities are expected to disrupt the essential behaviors, injure or kill 16 individuals of all life stages in Zone 1, and 65 individuals of all life stages in Zone 2. Explosive ordnance disposal training is also expected to affect marbled murrelet and bull trout prey species that spawn near Crescent Harbor; namely, surf smelt, Pacific herring, and Pacific sand lance individuals will be killed by explosions, but the number of deaths is not expected to lead to reductions in the populations of any of the forage fish species.

Habitat quality for marbled murrelet, bull trout and their prey resources have been reduced by shoreline armoring, overwater structure, marina, and road projects that the USFWS has consulted on. The amount of these changes varies but is generally correlated with development (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. Approximately 29 percent of Puget Sound shorelines are armored (Habitat Strategic Initiative 2021 p. 13) 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 habitat marbled murrelets and their prey resources.

10.6 Climate Change

Our analyses under the ESA include consideration of ongoing and projected changes in climate. The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2014a, pp. 119-120). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2014a, p. 119).

Measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change since the 1950s is unprecedented (IPCC 2014a, p. 40). Examples include warming of the atmosphere and the oceans, melting of glaciers and sea ice, and substantial increases in precipitation in some regions of the world with decreases in other regions (e.g., IPCC 2014a, pp. 40-42; Solomon et al. 2007, pp. 35–54, 82–85). Analyses presented by the Intergovernmental Panel on Climate Change (IPCC) show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is "extremely likely" (defined by the IPCC as 95 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2014a, pp. 47-49; Solomon et al. 2007, pp. 21–35). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011, p. 4), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 is caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl et al. 2007, entire; Ganguly et al. 2009, pp. 11555, 15558; Prinn et al. 2011, pp. 527, 529; van Vuuren et al. 2011, entire). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2035. After 2035, model projections diverge depending on initial assumptions about greenhouse gas emissions (Kirtman et al. 2013, pp. 978-980, 1004-1012; Collins et al. 2013, p. 1093). Although projections of the magnitude and rate of warming differ after about 2035, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the amount of GHG emissions (IPCC 2014a, pp. 56-63; Meehl et al. 2007, pp. 760–764 and 797–811; Ganguly et al. 2009, pp. 15555–15558; Prinn et al. 2011, pp. 527, 529). Other changes in the global climate are likely to include longer and more frequent heat waves, extreme precipitation events over mid-latitude land masses, intensified precipitation variability related to El Niño-Southern Oscillation (ENSO), reductions in spring snow cover and summer sea ice, sea level rise, ocean acidification, and decreases in the dissolved oxygen content of the ocean (IPCC 2014a, pp. 60-62).

Various changes in climate may have direct or indirect effects on listed species. These effects may be positive, neutral, or negative, and they may change over time. Identifying likely effects involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007, p. 89; see also Glick et al. 2011, pp. 19-22). There is no single method for conducting such analyses that applies to all situations (Glick et al. 2011, p. 3). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. In general, many species are projected to face increased extinction risk as the climate changes in the future, especially when climate changes are combined with other factors like habitat modification; but this risk can be reduced through management actions, including those that reduce the impacts of non-climate change stressors (IPCC 2014b, pp. 14-15).

10.6.1 Regional and Local Climate Projections

Global climate projections are informative, and in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (e.g., IPCC 2007, pp. 8-12). We therefore use "downscaled" projections when they are available, and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick et al. 2011, pp. 58-61, for a discussion of downscaling). With regard to our analysis of the action area, downscaled projections are available in some cases. The spatial scales addressed by the climate studies reviewed here range from the entire Northeast Pacific to specific areas of Puget Sound.

Many of the reports discussing downscaled or regional projections of climate change for the action area use a suite of climate models along with one or more scenarios for anthropogenic carbon emissions over time. The exact suite of models and scenarios varies among reports, but the climate models generally encompass a range of sensitivities to climate scenarios, and the emissions scenarios typically include a lower-emissions scenario and a higher-emissions scenario. A few studies report results of projections for the 2030s. However, most are reported in terms of a range of potential outcomes by the mid- or late 21st century. These projections indicate the direction of various environmental changes (i.e., increases vs. decreases), but are not informative about the magnitude of the expected change over increasingly long projections into the future. To account for this uncertainty, we have conservatively based our analysis of the effects of climate change on a 20-year time period.

10.6.2 Projected Changes in the Physical Environment

Projected changes to the climate within the action area include air and sea surface temperature increases, changes in precipitation seasonality, and increases in the frequency and intensity of extreme rainfall events (Mauger et al. 2015, pp. 2-1 – 2-18). Air temperature warming is already underway, and is expected to continue, with the mid-21st century projected to be approximately four to six degrees Fahrenheit (°F) (2.2 to 3.3 degrees Celsius [°C]) warmer than the late 20th century (Mauger et al. 2015, p. 2-5). Similarly, sea surface temperatures are already rising and the warming is expected to continue, with an increase of 2.2 °F (1.2 °C) projected for Puget Sound between the late 20th century and mid-21st century (Mote and Salathé 2010, p. 16). For the Strait of Georgia, projections suggest an increase of between 2.7 and 5.4 °F (1.5-3 °C) by the end of the 21st century (Riche et al. 2014, p. 41). Summer precipitation is expected to decrease by 22 percent (averaged across models, relative to the late 20th century) by the mid-21st century, while winter precipitation is expected to increase (Mauger et al. 2015, p. 2-7). In particular, heavy rainfall events are projected to occur approximately three times as frequently and to be about 19 percent more intense, on average, in the late 21st century than they were during the late 20th century (Warner et al. 2015, pp. 123-124).

The warming trend and trends in rainfall may be masked by naturally-occurring climate cycles, such as the ENSO and the Pacific Decadal Oscillation (PDO) (Reeder et al. 2013, p. 76). These oscillations have similar effects in the Pacific Northwest, with relatively warm coastal water and warm, dry winter conditions during a "positive" warm phase, followed by cooler coastal water and cooler, wetter winter conditions during the cool "negative" phase (Moore et al. 2008, p. 1747). They differ in that one phase of the ENSO cycle typically lasts between 6 and 18 months (one to three years for a full cycle), whereas, during the 20th century, each phase of the PDO cycle lasted approximately 20 to 30 years (approximately 40 to 60 years for a full cycle) (Mantua and Hare 2002, p. 36). Some studies break the PDO into two components, one with a full cycle length between 16 and 20 years and the other with a 50 to 70 year period, with the longer component referred to as the Pacific Multidecadal Oscillation (PMO) (Steinman et al. 2015, p. 988). Another recent study has identified a 60-year cycle separate from the longer-term component of the PDO, also referring to this as the PMO (Chen et al. 2016, p. 319). An additional pattern, the North Pacific Gyre Oscillation, is associated with changes in the alongshore winds that drive upwelling and appears to complete approximately one cycle per decade (Di Lorenzo et al. 2008, pp. 2-3).

The overall warming projections described above for the action area will be superimposed over the natural climate oscillations. The climate models used to project future trends account for naturally occurring cycles (IPCC 2014a, p. 56). Therefore, the projected trend combined with the existing cycles mean that temperatures during a cool phase will be less cool than they would be without climate change, and warm phases will be warmer. During the winter of 2014-2015, the climate shifted from a negative cool phase of the PDO to a positive warm phase (Peterson et al. 2016, p. 46). Additionally, one study predicts that the PMO will enter a positive warm phase around the year 2025 (Chen et al. 2016, p. 322). The phases of these long-term climate cycles in addition to the projected warming trend imply that we should expect sea surface temperatures during the period from 2017 through 2036 to be especially warm. However, climate change may also alter the patterns of these oscillations, for example, by shortening the cycle length of the PDO (Zhang and Delworth 2016, pp. 6007-6008). Many studies of climate effects to marine species and ecosystems use indices of these climate oscillations, rather than individual climate variables such as sea surface temperature, as their measures of the climatic state (e.g., Becker and Beissenger 2006, p. 473). Therefore, if climate factors that covary with a given oscillation become decoupled, the relationships inferred from these studies may no longer be valid in the future.

These changes in temperature and the seasonality of precipitation affect the freshwater inflows to Puget Sound. Spring and summer freshwater inflows are expected to be warmer and reduced in volume, whereas winter freshwater inflows are expected to increase (Mote et al. 2003, p. 56; Lee and Hamlet 2011, p. 110; Mauger et al. 2015, p. 3-8; Moore et al. 2015, p. 6). Many watersheds draining to Puget Sound have historically been fed by a mix of rain and snowmelt, but are expected to be increasingly dominated by rainfall, which will cause the timing of peak flows to shift from spring to winter (Hamlet et al. 2001, pp. 9-11; Elsner et al. 2010, pp. 248-249; Hamlet et al. 2013, pp. 401-404; Mauger et al. 2015, pp. 3-4 – 3-5). With winter warming and increases in heavy rainfall events, flooding has increased, and this increase is expected to continue (Hamlet and Lettenmaier 2007, pp. 25-16; Lee and Hamlet 2011, p. 113; Mauger et al. 2015, pp. 3-6 – 3-7). Increased winter freshwater inflows, in combination with melting glaciers, are expected to bring increased sediments to Puget Sound; however, it is uncertain whether these sediments are more likely to enter the Sound or to be deposited in estuaries (Czuba et al. 2011, p. 2; Lee and Hamlet 2011, pp. 129-134; Mauger et al. 2015, pp. 5-7 – 5-10).

These changes in seasonal freshwater inflows are expected to alter water circulation and stratification within the action area, and to affect the rate and timing of exchange of waters through the Strait of Juan de Fuca between the action area and the North Pacific Ocean (Babson et al. 2006, pp. 29-30; Riche et al. 2014, pp. 37-39, 44-45, 49-50; Mauger et al. 2015, p. 6-2; MacReady and Banas 2016, p. 13). This exchange occurs in two layers, with fresh water at the surface flowing toward the ocean, and denser, saltier ocean waters flowing from the ocean at greater depths (Babson et al. 2006, p. 30). With the projected changes in timing of freshwater inflows, the rate of exchange is expected to increase during winter and decrease during summer (Mauger et al. 2015, pp. 6-2 – 6-3). The effect of changes in freshwater inflow on stratification is likely to vary by location within the action area, with greater potential for effect in, for example, Budd Inlet and Commencement Bay than in well-mixed channels like Admiralty Inlet and Dana Passage (Newton et al. 2003, p. 721).

If changes in upwelling occur along the outer coast of Washington, these changes will also affect the interchange of waters through the Strait of Juan de Fuca (Newton et al. 2003, p. 718; Babson et al. 2006, p. 30). It has been hypothesized that as climate change accentuates greater warming of air over land areas than of air over the ocean, alongshore winds will intensify, which will lead to an increase in upwelling (Bakun 1990, entire). Historical records show that these winds have intensified over the past several decades (Bylhower et al. 2013, p. 2572; Sydeman et al. 2014, p. 78-79). Projections for future changes in upwelling offer some support for this hypothesis, but are more equivocal (Mote and Mantua 2002, p. 53-3; Wang et al. 2010, pp. 263, 265; Foreman et al. 2011, p. 10; Moore et al. 2015, p. 5; Rykaczewski et al. 2015, p. 6426;). Some studies indicate a trend toward a later, shorter (but in some cases, more intense) upwelling season (Bograd et al. 2009, p. 2; Foreman et al. 2011, p. 8; Bylhower et al. 2013, p. 2572). Within the action area, upwelling leads to an influx of waters rich in nutrients such as nitrates, phosphates, and silicates, but that are also acidic (due to high dissolved carbon dioxide content) and low in dissolved oxygen (Sutton et al. 2013, p. 7191; Johannessen et al. 2014, p. 220; Riche et al. 2014, pp. 45-46, 48).

Regardless of potential changes in the timing or intensity of upwelling, the dissolved oxygen content of the waters in the action area is expected to decrease. The solubility of oxygen in water decreases with increasing temperature, so as the climate becomes warmer, the dissolved oxygen content of the marine environment is expected to decrease (IPCC 2014a, p. 62; Mauger et al. 2015, pp. 7-3, 7-8). The oxygen content in the North Pacific Ocean just outside of the action area has declined significantly since measurements began in 1987 (Whitney et al. 2007, p. 184), and this decline is projected to continue (Whitney et al. 2013, p. 2204). As these waters flow into the action area, they drive down the oxygen content of action area waters, although there is considerable variation over time, space, and depth, due to patterns of circulation and mixing within the action area (Bassin et al. 2011, Section 3.2; Johannessen et al. 2014, pp. 214-220). For example, Hood Canal is particularly susceptible to hypoxic conditions, partly because circulation of water through Hood Canal is slow (Babson et al. 2006, p. 30), whereas the vigorous tidal currents in Haro Strait allow for the mixing of oxygen-rich surface water throughout the water column (Johannessen et al. 2014, p. 216). Increased stratification, as is expected during winter with the larger freshwater inflows, can lead to hypoxic conditions in deeper waters (Whitney et al. 2007, p. 189; Mauger et al. 2015, p. 6-3). On the other hand, weaker stratification, as expected in the summer, may decrease the probability of low oxygen due to greater mixing, or increase the probability of low oxygen due to slower circulation (Newton et al. 2003, p. 725). If upwelling does increase in intensity, the effect would likely be to further reduce the oxygen content of action area waters, but these changes are not likely to be consistent throughout the action area or throughout the year. Changes in oxygen content, or in the timing of low-oxygen periods, may have important biological consequences (see below). Oxygen content also responds to biological activity. In addition to climate change-induced effects, some locations will likely experience reductions in oxygen content stemming from biological responses to eutrophication in areas that receive (and do not quickly flush) nutrient inputs from human activities (Mackas and Harrison 1997, p. 14; Cope and Roberts 2013, p. 20-23; Roberts et al. 2014, p. 103-104, 108; Sutton et al. 2013, p. 7191).

Similarly, acidification of waters in the action area is expected to increase, regardless of any changes in upwelling. Acidification results when carbon dioxide in the air dissolves in surface water, and is the direct consequence of increasing carbon dioxide emissions (IPCC 2014a, p. 41, 49). Marine waters are projected to continue becoming more acidic, although if carbon emissions are stringently and immediately curtailed, this trend may reverse during the late 21st century (IPCC 2014a, p. 8-9, 49). Both the surface and upwelled waters of North Pacific Ocean just outside of the action area have become more acidic due to carbon dioxide emissions (Feely et al. 2008, pp. 1491-1492; Murray et al. 2015, pp. 962-963), and this trend is expected to continue (Feely et al. 2009, p. 40-46; Byrne et al. 2010; p. L02601). These waters contribute to acidification of the action area as they flow in through the Strait of Juan de Fuca (Feely et al. 2010, p. 446; Murray et al. 2015, p. 961), and any changes in upwelling intensity or seasonality would respectively increase acidification or change the timing of pH changes in the action area. It is unknown whether regional carbon dioxide emissions cause additional localized acidification within the action area (Newton et al. 2012, p. 36), but it is likely that other products of fossil fuel combustion, such as sulfuric acid, do contribute (Doney et al. 2007, p. 14582-14583). Linked to reductions in dissolved oxygen (Riche et al. 2014, p. 49), acidification has important biological consequences (see below), and also responds to biological activity. For example, local areas of eutrophication are likely to experience additional acidification beyond that caused directly or indirectly by carbon dioxide emissions (Newton et al. 2012, p. 32-33).

Sea level rise is also expected to affect the action area. Sea level rise is a consequence of the melting of glaciers and ice sheets combined with the expansion of water as it warms (IPCC 2014a, p. 42). At regional and local scales, numerous factors affect sea level rise, including ocean currents, wind patterns, and plate tectonics (Dalrymple 2012, p. 81; Mauger et al. 2015, p. 4-1; Petersen et al. 2015, p. 21). Sea level is rising at most locations in the action area (Shaw et al. 1998, p. 37; Dalrymple 2012, p. 79-81; Mauger et al. 2015, p. 4-2). These increases in sea level are likely to continue and may accelerate in the near future (Mote et al. 2008, p. 10; Dalrymple 2012, p. 71; Bromirski et al. 2011, p. 9-10; Mauger et al. 2015, p. 4-3 – 4-5; Petersen et al. 2015, p. 21, 29, and Appendix D). However, in some places, such as Neah Bay, plate tectonics are causing upward land movement that is currently outpacing sea level rise (Mote et al. 2008, p. 7-8; Dalrymple 2012, p. 80; Petersen et al. 2015, pp 24-26). In other places, sea-level rise is expected to have consequences for near-shore ecosystems (see below).

10.6.3 Projected Biological Consequences of Climate Change

Primary Productivity

Changes in temperature, carbon dioxide, and nutrient levels are likely to affect primary productivity by phytoplankton, macroalgae, kelp, eelgrass, and other marine photosynthesizers (Mauger et al. 2015, p. 11-5). In general, warmer temperatures, higher carbon dioxide concentrations, and higher nutrient levels lead to greater productivity (Thom 1996, pp. 386-387; Newton and Van Voorhis 2002, p. 10; Gao and Campbell 2014, p. 451, 454; Roberts et al. 2014, p. 11, 22, 108), but these effects vary by species and other environmental conditions, such as sunlight levels or the ratios of different nutrients (Low-Décarie et al. 2011, p. 2530; Gao and Campbell 2014, p. 451, 454). In particular, phytoplankton species that form calcium carbonate shells, such as coccolithophores, show weaker shell formation and alter their physiology in response to acidification (Feely et al. 2004, p. 365-366; Kendall 2015, p. 26-46). Due to changes in the seasonality of nutrient flows associated with upwelling and freshwater inputs, there may also be alterations in the timing, location, and species composition of bursts of primary productivity, for example, earlier phytoplankton blooms (Allen and Wolfe 2013, p. 6, 8-9; Mauger et al. 2015, p. 6-3; MacCready and Banas 2016, p. 17). Changes in primary productivity are not expected to occur in every season: during winter, sunlight is the major limiting factor through most of the action area (Newton and Van Voorhis 2002, p. 9, 12), and climate change is not expected to alter winter sunlight. Changes in primary productivity are also likely to vary across the action area; for example, primary productivity in Possession Sound is more sensitive to nutrient inputs than other areas within Puget Sound (Newton and Van Voorhis 2002, p. 10-11). In sum, we expect an overall increase in primary productivity, but there are likely to be changes in the timing, location, and species dominance of primary producers.

Eelgrass (*Zostera marina*) is a particularly important primary producer in the action area. In some areas, such as Padilla Bay, sea level rise is expected to lead to larger areas of suitable depth for eelgrass meadows. In such areas, eelgrass cover, biomass, and net primary production are projected to increase during the next 20 years (Kairis 2008, p. 92-102), but these effects will depend on the current and future topography of the tidal flats in a given area. In addition, eelgrass photosynthetic rates increase with increasing dissolved carbon dioxide concentrations (Thom 1996, p. 385-386; Short and Neckles 1999, p. 184-186). However, increasing temperatures are not likely to be beneficial for eelgrass, and in combination with increased nutrients, could favor algal competitors (Short and Neckles 1999, p. 172, 174; Thom et al. 2014, p. 4). Between 1999 and 2013, eelgrass growth rates in Sequim Bay have increased, but at a site in central Puget Sound, shoot density over a similar time period was too variable to detect trends (Thom et al. 2014, p. 5-6). Taken together, these studies indicate that climate change may benefit eelgrass over the next 20 years, particularly at some sites within the action area, but there is the potential for negative effects to dominate at other sites (Thom et al. 2014, p. 7-9).

Kelp forests also make important contributions to primary productivity in the action area, but are less well studied than eelgrass. Like eelgrass, bull kelp (*Nereocystis luetkeana*) responds to higher carbon dioxide concentrations with greater productivity (Thom 1996, p. 385-386). Outside of the action area, warming waters (among other factors) have reduced the range of giant kelp (*Macrocystis pyrifera* [Agardh]) (Edwards and Estes 2006, p. 79, 85; Ling 2008, p. 892), but it is not clear that the giant kelp populations within the action area will be negatively affected by the projected increase in temperature here. Within the action area, along the western portion of the Strait of Juan de Fuca, bull kelp and giant kelp canopy area increased between 1989 and 2004, but this increase is likely due to factors unrelated to climate change, such as harvesting of sea urchins, which graze on kelp (Berry et al. 2005, p. 4). It is unclear what the future effects of climate change might be on kelp in the action area.

In contrast, increases in toxic algae (also known as red tides or harmful algal blooms) have been documented over the past several decades, and these changes may be due to climate change (Trainer et al. 2003, p. 216, 222). Future conditions are projected to favor higher growth rates and longer bloom seasons for these species. In the case of one species, *Alexandrium catanella,* increases in the length of bloom season are projected primarily due to increases in sea surface temperature (Moore et al. 2015, p. 7-9). As with other climate change effects discussed above, increases in the length of the toxic algae bloom season is likely to vary across the action area. In the eastern end of the Strait of Juan de Fuca and the inlets of southern Puget Sound, the *A. catanella* bloom season is projected to increase by 30 days per year by 2069, in contrast with Whidbey basin, where little or no change in season length is projected (Moore et al. 2015, p. 8). In another species of toxic algae, *Pseudo-nitzschia fraudulenta*, toxin concentrations increase with increasing acidification of the water, especially in conditions in which silicic acid (used to construct the algal cell walls) is limiting (Tatters et al. 2012, p. 2-3). This species also exhibits higher growth rates with higher carbon dioxide concentrations (Tatters et al. 2012, p. 3-4). These results indicate that with future climate change, toxic algae blooms are likely to be more frequent, larger, and more toxic.

Higher Trophic Levels

There are several pathways by which climate change may affect species at higher trophic levels (i.e, consumers). Changing physical conditions, such as increasing temperatures, hypoxia, or acidification will have direct effects on some species. Other consumers will be affected via changes in the abundance, distribution, or other characteristics of their competitors or prey species. Changes in the timing of seasonal events may lead to mismatches in the timing of consumers' life history requirements with their habitat conditions (including prey availability as well as physical conditions) (Mackas et al. 2007, p. 249). The combination of these effects is likely to cause changes in community dynamics (e.g., competitive interactions, predator-prey relationships, etc.), but the magnitude of these effects cannot be predicted with confidence (Busch et al. 2013, p. 827- 831).

A wide variety of marine species are directly affected by ocean acidification. Like their phytoplankton counterparts, foraminiferans and other planktonic consumers that form calcium carbonate shells are less able to form and maintain their shells in acidified waters (Feely et al. 2004, p. 356-366). Similarly, chemical changes associated with acidification interfere with shell development or maintenance in pteropods (sea snails) and marine bivalves (Busch et al. 2014, p. 5, 8; Waldbusser et al. 2015, p. 273-278). These effects on bivalves can be exacerbated by hypoxic conditions (Gobler et al. 2014, p. 5), or ameliorated by very high or low temperatures (Kroeker et al. 2014, p. 4-5), so it is not clear what the effect is likely to be in a future that includes acidification, hypoxia, and elevated temperatures. Acidification affects crustaceans, for example, slowing growth and development in Pacific krill (*Euphausia pacifica*) and Dungeness crabs (*Cancer magister*) (Cooper et al. 2016, p. 4; Miller et al. 2016, p. 118-119). Salmon are also negatively affected by acidification, including negative growth rates and reduced metabolic rates in juvenile pink salmon (*Oncorhynchus gorbuscha*) at carbon dioxide concentrations comparable to those recently observed in the Strait of Georgia (Ou et al. 2015, p. 951, 954).

Climate effects are expected to alter interactions within the marine food web. When prey items decrease in abundance, their consumers are also expected to decrease, and this can also create opportunities for other species to increase. In California's Farallon Islands, the recently increasing variance of climate drivers is leading to increased variability in abundance of prey species such as euphausiids and juvenile rockfish (*Sebastes* spp.), associated with corresponding variability in the demography of predators such as seabirds and salmon (Sydeman et al. 2013, p. 1662, 1667-1672). In future scenarios with strong acidification effects to benthic prey in the California Current, euphausiids and several fish species are expected to decline, while other species are expected to increase (Kaplan et al. 2010, p. 1973-1976). An investigation of the planktonic food web off the coast of Oregon shows that sea surface temperature has contrasting effects on different types of zooplankton, and competitive interactions are much more prevalent during warm phases of ENSO or PDO than during cool phases (Francis et al. 2012, p. 2502, 2505-2506). A food web model of Puget Sound shows that moderate or strong acidification effects to calcifying species are expected to result in reductions in fisheries yield for several species, including salmon and Pacific herring, and increased yield for others (Busch et al. 2013, p. 827-829). Additionally, the same model shows that these ocean acidification effects are expected to cause reductions in forage fish biomass, which are in turn expected to lead to reductions in diving bird biomass (Busch et al. 2013, p. 829). While Busch and coauthors (2013, p. 831) express confidence that this model is accurate in terms of the nature of ocean acidification effects to the Puget Sound food web of the future, they are careful to note that there is a great deal of uncertainty when it comes to the magnitude of the changes. The model also illustrates that some of the effects to the food web will dampen or make up for other effects to the food web, so that changes in abundance of a given prey species will not always correspond directly to changes in the abundance of their consumers (Busch et al. 2013, p. 827, 830).

Changes in seasonality at lower trophic levels may lead to changes in population dynamics or in interactions between species at higher trophic levels. For example, just outside of the action area in British Columbia, earlier spring phytoplankton blooms are associated with lower pink salmon productivity, likely mediated by zooplankton grazers, and this effect is likely to apply to the action area as well (Malick et al. 2015, p. 703-706). Similarly, if salmon hatchery release dates are not adjusted to account for changes in peak timing of phytoplankton blooms, this can lead to a mismatch between release dates and marine productivity peaks, which has been shown to reduce smolt-to-adult survival in the Strait of Georgia (Chittenden et al. 2010, p. 8-9). At Triangle Island in British Columbia, Cassin's auklet (*Ptychoramphus aleuticus*) breeding success is reduced during years when the peak in copepod prey availability comes earlier than the birds' hatch date, and this mismatch is associated with warm sea surface temperatures (Hipfner 2008, p. 298-302). However, piscivorous seabirds (i.e., tufted puffins [*Fratercula cirrhata*], rhinoceros auklets [*Cerorhinca monocerata*], and common murres [*Uria aalge*]) breeding at the same Triangle Island site have, at least to some extent, been able to adjust their breeding dates according to ocean conditions (Bertram et al. 2001, p. 292-293; Gjerdrum et al. 2003, p. 9379), as have Cassin's auklets breeding in the Farallon Islands of California (Abraham and Sydeman 2004, p. 240). Because of the changes in tufted puffin, rhinoceros auklet, and common murre hatch dates at Triangle Island, the breeding periods of these species have converged to substantially overlap with one another and with that of Cassin's auklet (Bertram et al. 2001, p. 293-294), but studies have not addressed whether this overlap has consequences for competitive interactions among the four species. Note that all four of these bird species are in the family Alcidae, which also contains marbled murrelets. All these species also breed in, or just outside, the action area and forage within the action area. However, we did not locate any studies addressing these types of effects within the action area.

Several studies have suggested that climate change is one of several factors allowing jellyfish to increase their ecological dominance, at the expense of forage fish (Parsons and Lalli 2002, p. 117-118; Purcell et al. 2007, p. 154, 163, 167-168; Richardson et al. 2009, p. 314-216). Many (though not all) species of jellyfish increase in abundance and reproductive rate in response to ocean warming, and jellyfish are also more tolerant of hypoxic conditions than fish are (Purcell 2005, p. 472; Purcell et al. 2007, p. 160, 163; see Suchman et al. 2012, pp. 119-120 for a Northeastern Pacific counterexample). Jellyfish may also be more tolerant of acidification than fish are (Attrill et al. 2007, p. 483; Lesniowski et al. 2015, p. 1380). Jellyfish abundance in southern and central Puget Sound has increased since the 1970s (Greene et al. 2015, p. 164). Over the same time period, herring abundance has decreased in south and central Puget Sound, and surf smelt (*Hypomesus pretiosus*) abundance has also decreased in south Puget Sound, although other Puget Sound forage fish populations have been stable or increasing (Greene et al. 2015, p. 160-162). Forage fish abundance and jellyfish abundance were negatively correlated within Puget Sound and Rosario Strait (Greene et al. 2015, p. 164). It is not clear whether there is a causal relationship between forage fish and jellyfish abundance, or whether the two groups are simply responding in opposite ways to climate and other anthropogenic factors.

Many species of forage fish are expected to fare poorly in the changing climate, regardless of any competitive effects of jellyfish. In the Gulf of Alaska, Anderson and Piatt (1999, p. 119-120) documented the crash of capelin (*Mallotus villosus*), Pacific herring, and species of Irish lord (*Hemilepidotus* spp.), prickleback (Stichaeidae family), greenlings and mackerel (*Hexagrammos* and *Pleurogrammus* spp.), as well as several shrimp species, as part of a major community reorganization following a climate regime shift from a cool phase to a warm phase in the 1970s. In the northeastern Pacific Ocean, capelin, sand lance (Ammodytidae family), and rockfish abundance are all negatively correlated with seasonal sea surface temperatures (Thayer et al. 2008, p. 1616). A model of multiple climate change effects (e.g., acidification and deoxygenation) to marine food webs in the Northeast Pacific consistently projects future declines in small pelagic fish abundance (Ainsworth et al. 2011, p. 1219, 1224). Within the action area, abundance of surf smelt and Pacific herring in the Skagit River estuary are positively associated with coastal upwelling during the spring and early summer, likely because nutrient-rich upwelled water increases food availability (Reum et al. 2011, p. 210-212). If projections of later, shorter upwelling seasons are correct (see above), the delays may lead to declines in these stocks of herring and surf smelt, as happened in 2005 (Reum et al. 2011, p. 212). Similarly, delayed upwelling in 2005 led to reduced growth rates, increased mortality, and recruitment failure of juvenile northern anchovies (*Engraulis mordax*) off of the Oregon and Washington coasts (Takahashi et al. 2012, p. 397-403). In the northeastern Pacific, Chavez and coauthors (2003, pp. 217-220) have described a shift between an "anchovy regime" during the cool negative phase of the PDO and a "sardine regime" during the warm positive phase, where the two regimes are associated with contrasting physical and biological states. However, global warming may disrupt the ecological response to the naturally-occurring oscillation, or alter the pattern of the oscillation itself (Chavez et al. 2003, p. 221; Zhang and Delworth 2016, entire).

10.6.4 Bull Trout

The Recovery Plan summarizes our current knowledge of potential future climate change scenarios, and their significance for bull trout recovery (USFWS 2015a, pp. 17-19, 30, 31). Bull trout are vulnerable to the effects of warming climates and changing precipitation and hydrologic regimes. Climate change in the Pacific Northwest will include rising air temperatures, changes in the timing and volume of streamflow, increases in extreme precipitation events, and other changes that are likely to degrade bull trout habitat and increase competition with non-native warmwater fish (Mote et al. 2014).

Several climate change assessments or studies have been published (Rieman et al. 2007; Porter and Nelitz. 2009; Rieman and Isaak 2010; Isaak et al. 2010, 2011; Wenger et al. 2011; Eby et al. 2014) or are currently underway assessing the possible effects of climate change on bull trout. The results of these efforts will allow us to better understand how climate change may influence bull trout, and help to identify suitable conservation actions to improve the status of bull trout throughout their range. Issues include: the effects of rising air temperatures and lower summer flows on range contractions; changing stream temperatures, influenced by stream characteristics (e.g., amount of groundwater base flow contribution to the stream, stream geomorphology, etc.) affecting suitable bull trout spawning and rearing habitat; threats to redds and juvenile habitat from stream scouring caused by increased winter precipitation extreme events and increased rain in lower elevations; and lower summer flows inhibiting movement between populations, and from spawning and rearing habitat to foraging habitat (USFWS 2015a, p. 18).

Climate change is an independent threat to bull trout, but also one that exacerbates many of the other threats. The USFWS expects the threat to increase in severity over coming decades. Increasing air temperatures and other changes to hydrology, modified by local habitat conditions, will tend to result in increased water temperatures, and reduce the amount of habitat with suitable cold water conditions. Warm dry conditions are also likely to increase the frequency and extent of forest fires, with a potential to increase sedimentation and eliminate riparian shading. Projected lower instream flows and warmer water in FMO habitats will exacerbate the lack of connectivity within and between bull trout core areas. And we expect that increased water temperatures will alter competitive interactions between bull trout and other fish species that are better adapted to warm conditions. Climatic warming will change seasonality of streamflow, and increased spring runoff from rain-on-snow events will increase scouring of spawning gravels. Glacial retreat and reduction of summer snowpack will reduce cold water flows during summer months. Sea level rise will result in the loss of, and changes to, nearshore and estuarine habitat. Although addressing the root causes of greenhouse gas emissions and climate change is not within our jurisdiction, management planning should account for these increased threats and proactively protect those habitats that we expect will best maintain cold water conditions suitable for bull trout (USFWS 2015a, pp. 30, 31).

10.6.5 Marbled Murrelet

Marbled murrelets are likely to experience changes in foraging and breeding ecology as the climate continues to change. Within the action area, there is no research attempting to measure or project the effects of climate change on the marbled murrelet. However, several related studies have been conducted outside of the action area, and the results are likely to be applicable to marbled murrelets within the action area as well. Additionally, numerous studies of other alcids from Mexico to British Columbia indicate that alcids as a group are vulnerable to climate change in the northeastern Pacific.

These studies suggest that the effects of climate change will be to reduce marbled murrelet reproductive success, likely mediated through climate change effects to prey. In British Columbia, there is a strong negative correlation between sea surface temperature and the number of marbled murrelets observed at inland sites displaying behaviors associated with nesting (Burger 2000, p. 728). In central California, marbled murrelet diets vary depending on ocean conditions, and there is a trend toward greater reproductive success during cool water years, likely due to the abundant availability of prey items such as euphausiids and juvenile rockfish (Becker et al. 2007, pp. 273-274). In the Georgia Basin, just north of the action area, much of the yearly variation in marbled murrelet abundance from 1958 through 2000 can be explained by the proportion of fish (as opposed to euphausiids or amphipods) in the birds' diet (Norris et al. 2007, p. 879). If climate change leads to further declines in forage fish populations (see above), those declines are likely to be reflected in marbled murrelet populations.

The conclusion that climate change is likely to reduce marbled murrelet breeding success via changes in prey availability is further supported by several studies of other alcid species in British Columbia and California. Common murres, Cassin's auklets, rhinoceros auklets, and tufted puffins in British Columbia; pigeon guillemots (*Cepphus columba*), common murres, and Cassin's auklets in California; and even Cassin's auklets in Mexico all show altered reproductive rates, altered chick growth rates, or changes in the timing of the breeding season, depending on sea surface temperature or other climatic variables, prey abundance, prey type, or the timing of peaks in prey availability (Ainley et al. 1995, pp. 73-77; Bertram et al. 2001, pp. 292-301; Gjerdrum et al. 2003, pp. 9378-9380; Abraham and Sydeman 2004, pp. 239-243; Hedd et al. 2006, pp. 266-275; Albores-Barajas 2007, pp. 85-96; Borstad et al. 2011, pp. 291-299). The abundance of Cassin's auklets and rhinoceros auklets off southern California declined by 75 and 94 percent, respectively, over a period of ocean warming between 1987 and 1998 (Hyrenbach and Veit 2003, pp. 2546, 2551). Although the details of the relationships between climate variables, prey, and demography vary between bird species and locations, the consistent demonstration of such relationships indicates that alcids as a group are sensitive to climate-related changes in prey availability, prompting some researchers to consider them indicator species for climate change (Hyrenbach and Veit 2003, p. 2551; Hedd et al. 2006, p. 275).

In addition to effects on foraging ecology and breeding success, climate change may expose adult marbled murrelets to health risks. For example, it is likely that they will experience more frequent domoic acid poisoning, as this toxin originates from harmful algae blooms that are expected to become more prevalent in the action area (see above). In central California, domoic acid poisoning was determined to be the cause of death for at least two marbled murrelets recovered during a harmful algae bloom in 1998 (Peery et al. 2006, p. 84). During this study, which took place between 1997 and 2003, the mortality rate of radio-tagged marbled murrelets was highest during the algae bloom (Peery et al. 2006, p. 83). Domoic acid poisoning has previously been shown to travel through the food chain to seabirds via forage fish that feed on the toxic algae (Work et al. 1993, p. 59). A different species of harmful algae produces a foam that led to plumage fouling and subsequent mortality of common murres and other seabird species off of Oregon and Washington during October of 2009, and similar events may become more frequent with climate change (Phillips et al. 2011, pp. 120, 122-124). Climate change may also promote conditions in which alcids become exposed to novel pathogens, as occurred in Alaska during 2013, when crested auklets (*Aethia cristatella*) and thick-billed murres (*Uria lomvia*) washed ashore after dying of avian cholera (Bodenstein et al. 2015, p. 935). Counterintuitively, in the 1997-2003 study of radio tagged marbled murrelets in California, marbled murrelet adult survival was higher during warm-water years and lower during cold-water years, likely because they did not breed and therefore avoided the associated physiological stresses and additional predator risk (Peery et al. 2006, pp. 83-85).

10.6.6 Summary of Climate Change Effects

In summary, we are reasonably certain that projected changes in regional air and water temperatures, precipitation patterns, and ocean chemistry will impact bull trout and marbled murrelet. These changes may result in a further decline in prey resource (forage fish, juvenile salmonids) availability, timing, or nutritive value. However, as described above, climate change projections, and interactions of the physical environment and biological system response are complex and uncertain. USFWS has conservatively estimated that the effects of climate change and resulting impacts on habitat factors (including prey resource availability) important to bull trout and marbled murrelet can be reliably projected for 20 years. It is reasonable to assume the regional understanding of appropriate adaptive responses will emerge over the next two decades with an improved understanding of climate change impacts to Salish Sea resources. USFWS anticipates new information is highly likely to emerge during that timeframe regarding the proposed action, including but not limited to changes to project design criteria, type and location of conservation offsets, and regional climate adaptation strategies, potentially necessitating reinitiation of the SSNP consultation.

11 EFFECTS OF THE ACTION

Effects of the action are the direct and indirect effects of an action on the species or critical habitat together with the effects of other activities that are interrelated or interdepend with that action that will be added to the environmental baseline (50 CFR 402.02). An effect is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. For our effects analysis, USFWS estimated the levels of activity based on the estimated number of projects provided by the Corps in the proposed action and a review of historic data on activity level common under the covered activities. Our rationale is provided in Section 11.1, with species specific effects analyses in the following sections.

11.1 Assumptions of Project Level Future Activity under SSNP

Conservation offsets and PDCs described in the proposed action are intended to reduce the magnitude or duration of effects; however effects of the proposed action cannot be fully avoided. Effects of the action include 1) the short-duration effects associated with any construction element (new, repair/replacement, or maintenance) at any given location; 2) enduring (long-term) effects associated with the alteration of habitat conditions and processes that exist for the duration of a structures' presence; and 3) beneficial effects of the conservation offsets.

Stressors associated with construction of structures and of the conservation offsets will include reductions in water quality, increased sound in the aquatic environment, alterations in prey/forage (benthic prey, forage fish, prey fishes) resources, and fish handling/exclusion at construction sites. The use, operation, and maintenance of the structures will generate several types of chronic and episodic habitat effects that will occur while the structures are present in the environment. Episodic habitat effects include water quality reductions from vessel use and unmanaged and managed stormwater from upland areas, in-air and underwater sound from vessel operation, scour from vessel operation, and turbid conditions associated with maintenance dredging of navigational areas. These episodic and persistent effects are co-extensive with the respective design lives of the new, expanded, repaired or replaced wharfs, piers, docks, floats, and 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 altered predator/prey dynamics related to-water structure, disrupted migration areas related to in and overwater structure, and modified shoreline and nearshore processes related to bank armoring and in-water structure. These effects are chronic, persistent, and co-extensive with the design life of the structure.

To estimate project level effects, the USFWS relied on information of the estimated number of projects that the Corps provided in the proposed action (Table 1); projects implemented under the USFWS and NMFS programmatic consultation on the Corps Seattle District Regional General Permit #6 from May 2017 to December 2019[33] (the period covered by the Corps most recent monitoring report)(referred to as "RPG-6); and individual consultation requests between August 1, 2020 and April 1, 2022. To further understand the level of activity expected under SSNP, more specific information was collected for each of the projects on: (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; (4) cubic yards of material dredged (Table 7). These data were compared with the number of possible projects that could occur in relation to the estimates in the proposed action. For example, we expect impact or vibratory pile driving could occur as part of any project approved under PDCs #1, #4, #6, #7, and #8 or a total of 249 possible projects. Based on the frequency of pile driving in past projects, we assume that not all possible projects will include pile driving as a component. Therefore, the

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[33] These projects are repair, replacement, or replacement of residential pier, ramp, and floats.

USFWS assumes that only a proportion (80 percent) of these projects will include pile driving and fewer will include piles greater than 12 inches. This rationale defined our estimate per year of projects that may include a pile driving component (Table 7).

To determine the total impact over the assumed period of use of this programmatic consultation framework, we further multiplied the anticipated yearly impact by 20 years, or the duration where the USFWS can reasonably determine impacts to the target species when factoring in climate change, population growth, and existing development trends within the action area. These estimates provide our expected level of activity over a 20-year period. The USFWS assumes that in some years, project activities may exceed the yearly total and other years will be less, but that the total impact will not exceed the 20-year totals. These yearly and 20-year totals are used to determine the level of impact to marbled murrelet, bull trout, and designated bull trout critical habitat.

Table 7. Estimated level of activity anticipated under SSNP in relation to number of projects per PDC and used to determine effects to listed species and their habitat.

Activity	PDCs where activity expected	Estimated number of projects per year	Average per Project	Total Impact per Year	Total Impact over 20 years
Pile Installation, replacement	1, 4, 6, 7, 8	149[a] projects including <12" piles 62[b] projects including >12" to 36" piles	piles per project 2 piles per project	1,494 piles <12" 125 piles 12"-36"	29,880 piles <12" 2,490 piles 12"-36"
Dredging for Vessel Access	9	5	<6,715 CY	<33,575 CY	<671,500 CY
Dredging for Culvert and Outfall Function	10	9	<50 CY	<450 CY	<9,000 CY
Shoreline Armoring (repair, replace, and new)	1, 4, 5, 6, 12	63[c] projects	<400 linear ft	<24,000 linear ft	<480,000 linear ft
New or Expanded Overwater Structure	1, 4, 5	95	<1,158 sq ft	<110,000 sq ft	<2,200,000 sq ft
Repair or replacement overwater structure	1, 4, 5	95	<1,158 sq ft	<110,000 sq ft	<2,200,000 sq ft
Fish Handling or Rescue and Entrainment from Dredging	1, 4, 5, 6, 7, 9 10, 11	277		<277 bull trout per year; no more than 5% mortality	<5,540 bull trout; no more than 5% mortality
Sediment Remediation	14	17	875 CY or <3 acres per project	<14,875 CY or <50 acres	<297,500 CY or <1,000 acres

[a] Assumes 80 percent of possible projects (249) will include impact pile driving of piles smaller than 12" diameter.
[b] Assumes 25 percent of possible projects (249) will include impact driving of piles greater than 12" diameter.
[c] Assumes 25 percent of possible projects (250) will include shoreline armoring.

It is important to note that the effects to bull trout, designated bull trout critical habitat, and marbled murrelet associated with individual projects will vary based upon the scope, scale and the location of each individual project. Table 7 provides the assumptions needed to provide a reasonable worst case assessment of the potential effects that bull trout or marbled murrelet within the action area may experience. The following sections provide detailed analysis of the different types of effects and their magnitude that are expected to occur given the anticipated numbers of projects described in the Table 1 and Table 7.

Conservation offsets may occur:

> onsite as part of the applicant's project,
>
> within-basin habitat improvements at the responsibility of the applicant,
>
> offsite through funding to a local habitat restoration sponsor, or
>
> through a USFWS-approved conservation bank, in-lieu fee program and/or crediting provider whose service area overlaps the action area.

Actions associated with conservation offsets included in an applicant's project description are covered under SSNP and are included within the possible project impacts summarized in Table 7. In addition, many of the activities qualifying for conservation offsets are included as part of the programmatic action for SSNP (PDCs #11, #12, #13, and #14). The overall intent of the conservation offsets is to provide improvements to habitat function within the action area and ultimately provide long-term beneficial effects to species and critical habitat. These activities are reasonably certain to lead to some degree of ecological recovery and improved habitat function, including the establishment or restoration of environmental conditions associated with functional nearshore habitat. The removal of over-water structures reduces long-term impacts to forage species and their habitat. Removal of in-water structures such as treated-wood piles also removes or eliminates persistent sources of contaminants. Connection of the floodplain provides habitat for rearing forage species such as juvenile salmon. These types of habitat function and improvement are expected to improve ecological conditions for bull trout and marbled murrelet through increased prey resource availability over time. Localized construction-related impacts are also expected from implementation of conservation offsets and included in the detailed analyses in the following sections.

The purchases of conservation bank credits will lead to improved habitat quality. However, these improvement may be off-site, out-of-kind or take several years for implementation. Similarly, contributions to in-lieu fee programs generally result in habitat improvements but the improvement can be delayed and is typically off-site. The USFWS anticipates that some of the conservation offsets will be part of larger projects requiring an individual consultation under the ESA and may occur without a direct relationship to permitted activities under SSNP. For example, an applicant may obtain a permit from the Corps to replace a dock utilizing the SSNP programmatic consultation and purchase conservation offset credits to do so. That purchase may be combined with other funding by the entity undertaking the habitat restoration effort to complete a larger habitat restoration project and occur later in time, out of basin, or outside the confines of the applicant's project. The habitat restoration action would require an individual project review under the ESA assuming a federal nexus and an effect to listed species. Therefore, the USFWS recognizes that conservation offsets are occurring in relation to actions authorized by the Corps under the SSNP, but unless the activity occurs under a Corps authorization and meets all criteria in the proposed action, the habitat restoration action will require further site-specific analyses under the ESA by the implementing agency.

11.2 Bull Trout and Designated Bull Trout Critical Habitat

Insignificant, adverse, and beneficial effects to bull trout and their designated critical habitat are anticipated from elements of the SSNP.

11.2.1 Exposure Analysis

Bull Trout occur throughout the aquatic portions of the action area and represent individuals from as many as nine core areas within the Coastal Recovery Unit. We expect that bull trout utilizing the action area for foraging, migrating or overwintering are sub-adult and adults. Exposure to juvenile bull trout is not expected because spawning and rearing areas occur in headwaters of core area watersheds and not within the action area.

Across the action area, data are lacking on bull trout occurrence and population size. Number of bull trout are difficult to estimate as there are no comprehensive surveys or sampling efforts, and their utilization of the action area is not fully understood. In general, we expect that bull trout occur in relatively low numbers, and in relatively low densities throughout the Salish Sea (Table 5). As such, the number of bull trout exposed to any one action component is expected to be very small. The largest populations of bull trout within the Salish Sea originate in the Chilliwack and Lower Skagit Core Areas. These two core areas host more than 1000 individuals each and approximately half of adults and subadults studied entered the marine environment in any given year (Brenkman and Corbett 2005; Goetz et al. 2007). All other core areas host fewer than 1000 individuals. Bull trout from core areas that do not have a major lake or reservoir typically have higher frequencies of anadromy such as the Stillaguamish or Elwha Core Areas. The majority of anadromous bull trout are likely near estuaries and other areas of with high quality forage resources.

Generally, bull trout move from freshwater into the marine environment in March through June, and then return to freshwater in July and August as temperatures in embayments and estuaries begin to rise (Goetz et al. 2021 p. 1080; Hayes et al. 2011 p 400). During their marine residency, bull trout adults and subadults forage in nearshore areas that are 2m to as much as 183m deep (Goetz et al. 2004; Goetz et al. 2021). In addition, bull trout have been documented as far as 400m from shore, but the majority of observations are within 100m of shore (Hayes et al. 2011). While most (>75 percent) studied bull trout have left marine waters by August, a small proportion stay in marine waters year-round when not spawning (Table 5). As such, we expect that there is a year-round potential for exposure of bull trout to stressors associated with the proposed action.

Given the timing and likely numbers of bull trout entering the action area, combined with the expansive area of the Salish Sea, and the timing of most construction activities within salmonid migrating, foraging and rearing areas (July 15 through February 15), the USFWS anticipates few bull trout (<5) from any one population would be exposed to short-term stressors associated with construction of individual projects and conservation offsets. These stressors include elevated underwater sound, direct handling, and altered water quality. Long-term changes to forage resources resulting from the proposed action have the greatest potential for exposure to bull trout individuals and populations over the anticipated 20-year duration of our effects analysis.

11.2.2 Effects of the Action on Bull trout and Designated Bull Trout Critical Habitat

The following analysis is organized based on the effects to bull trout individuals and designated critical habitat. In the following sections, the breakdown of effects focuses on categories of "stressors." Stressors are any change in the environment that can elicit a response from a species or features of critical habitat. A species may respond to a stressor when the stressor (1) impacts the resources the species requires to fulfill its life cycle or (2) directly interacts with the species itself. The response may be negative, neutral, or positive. The stressors expected to result from the proposed action are related to: a) direct impacts to bull trout related to elevated underwater sound and human activity, handling and salvage operations; b) water quality impairments (PCE # 8) from stormwater runoff, elevated turbidity, and contaminants; c) migration barriers (PCE #2 and PCE #4) from structures and operations; and d) altered forage (PCE 3#) conditions.

11.2.3 Direct Effects to Bull Trout Individuals

Exposure to Elevated Sound

High levels of underwater sound can injure or kill fish and cause alterations in behavior (Popper et al. 2014 p. 17; Halvorsen et al. 2011 p.3; Halvorsen et al. 2012 p. 7; 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 in the absence of mortality, elevated 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).

Exposure to underwater sound can also result in internal bleeding and stunning (complete immobilization). Approximately 50 percent of fish died when exposed to a sound level of 192dBPeak and 400 Hz, 56 percent died at a sound level of 198dBPeak and 150 Hz, and 25 percent died when exposed to a sound level of 204dBPeak and 250 Hz in cage tests (Hastings 1995, p. 981). Impulses can also injure and/or kill fish by causing barotraumas (pathologies associated with high sound levels including hemorrhage and rupture of internal organs) (Turnpenny and Nedwell 1994; Turnpenny et al. 1994, p. 58-60; Popper 2003, p. 28-30; Hastings and Popper 2005). The injuries associated with exposure to impulses are referred to as barotraumas, and include hemorrhage and rupture of internal organs, hemorrhaged eyes, and temporary stunning (Yelverton et al. 1973, p. 37; Yelverton et al. 1975, p. 17; Yelverton and Richmond 1981, p. 6; Turnpenny and Nedwell 1994; Hastings and Popper 2005). Death from barotrauma can be instantaneous, occurring within minutes after exposure, or several days later (Abbott et al. 2005). Necropsy results from shiner perch exposed to impulses showed fish with extensive internal bleeding and a ruptured heart chamber were still capable of swimming for several hours before death (Abbott et al. 2005, p. 29). Sublethal injuries can reduce osmoregulatory efficiency and increase energy expenditure (Gaspin et al. 1976, p. 32; Govoni et al. 2008, p. 1) and can affect equilibrium and interfere with the ability to carry out essential life functions such as feeding and predator avoidance (Gaspin 1975, p. 32; Turnpenny et al. 1994; Hastings et al. 1996; Popper 2003).

Adverse effects on survival and fitness can occur even in the absence of overt injury. Exposure to elevated sound 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 cumulative sound exposure levels (SELs) as low as 184dB. 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.

The NMFS and USFWS developed interim criteria to identify and thus help avoid potential impacts of pile driving on fishes (FHWG 2008 p.1). The interim criteria include peak sound pressure level (SPL) and SEL injury threshold limits of:

> Peak SPL: levels at or above 206dB from a single hammer strike likely results in the onset of physical injury.
>
> SEL: cumulative levels at or above 187dB for fish sizes of 2 grams or greater, or 183dB for fish smaller than 2 grams.

More recent research suggests that the existing interim criteria are conservative. Halvorsen et al (2012) found the onset of injury for Chinook salmon occurred at a cumulative 210dB$_{SEL}$ and proposed updating the criteria as the current criteria indicated the onset of injury at a cumulative 187dB$_{SEL}$ (Table 8). Their analysis was based on an injury response variable and factored in multiple strikes with a single strike severity (Halvorsen et al 2011, 2012; Popper et al 2014 p, 34). In follow-up, Popper et al (2014, p. 42 Table 7.3) refined their recommendations on mortal injury (peak >207dB and cumulative SEL 207dB) and recoverable injury (peak >207dB and cumulative SEL 203dB). As well, they provided new recommendations for levels of temporary threshold shift (cumulative SEL 186dB) and indicated a relative risk for behavioral changes of moderate to high in the near, intermediate, and far field (distance from pile driving activity). Currently, an interagency group consisting of the Navy, Federal Highway Administration, Bureau of Ocean Energy Management, U.S. Geological Survey, Corps, Federal Transit Administration, NMFS, and USFWS are considering revisions to the existing interim threshold criteria defined in FHWG 2008.

Table 8. Comparison of existing interim criteria with new recommendations for impacts of underwater sound on fish from pile driving.

Impact Level to fish	**Interim Criteria (FHWG 2008)**	**Recommended Criteria (Popper et al 2014)**
Onset of injury	Peak 206dB Cumulative 187dB SEL for fish >2grams Cumulative 183dB SEL for fish <2 grams	Peak >207dB Cumulative 203dB SEL
Behavioral	None	Cumulative 186dB SEL

(FHWG 2008; Popper et al 2014)

Our analysis of impact is based on the existing more conservative interim criteria (Table 8) in FHWG (2008), while recognizing that newer information suggests much lower levels of mortality, injury or behavioral changes are likely. The proposed project occurs within marine and estuarine waters of the Salish Sea where all bull trout present would be adults or subadults (>150mm), therefore we do not expect any bull trout smaller than two grams (approximately 50-60mm) to be within the action area of this proposed action.

The proposed project includes several activities that might require pile driving such as pile placement, coffer dam sheet piles, dolphin repairs. The USFWS anticipates both vibratory and impact pile driving associated with PDC #1, PDC #4, PDC #5, PDC #6, PDC #7, and PDC #8. If we assume a worst-case scenario that all proposed available projects for these PDCs include pile driving, as many as 249 projects could include pile driving. However, this would vastly overestimate the number of pile driving projects that may occur each year since activities such as culvert replacement or a boat launch may not require pile placement. Therefore, we have assumed that 80 percent of the possible projects would require placement of piles.

Our history of consultations on pile installation reveals that most structures use 12-inch steel piles. Therefore, we assume up to 149 projects will occur each year and on average each of these projects would install ten 12-inch piles per site (up to 1494 piles average per year or 29,880 over the 20-year duration of our effects analysis). While our analysis assumes an average of 10 piles per project, we recognize some projects will be larger and some smaller and the total average number of piles installed per year over the full 20-year duration of our analysis represents the full impact of pile driving effects. The USFWS assumes that a smaller portion of projects (approximately 25 percent) will require large piles greater than 12 inches diameter. We anticipate 62 projects per year will require installation on average of up to two large piles (125 total piles) in any given year.

To determine the level of underwater sound impact, the USFWS analyzed the total area affected by the above quantities of 12-inch and 36-inch piles that may be placed. As the largest sized pile allowed under SSNP, we chose 36-inch piles for analytical purposes to provide a worst-case analysis on the distance for elevated underwater sound. The use of smaller piles would result in smaller areas of elevated underwater sound. The USFWS used the following assumptions based on past projects to determine the effects of pile driving on bull trout:

> No more than eight 12-inch piles may be driven per day at any one project site.
>
> No more than two piles greater than 12 inches may be driven per day at any one project site without a marbled murrelet monitoring plan. Up to 8 piles greater than 12 inches may be driven in a day, as long as a marbled murrelet monitoring plan is in place.
>
> After using a vibratory hammer, each pile will take up to 500 impact strikes.
> The confined or unconfined bubble curtain will result in a 10dB reduction.

Given the assumptions above and based on the annual limit for pile type and size, underwater sound from the driving of two 36-inch piles at each of 62 sites would exceed the injury thresholds at 24 feet for $206\text{dB}_{\text{peak}}$, 1,120 feet for fish greater than or equal to two grams 187 SEL_{cum}.

For the remainder of annual projects (149 projects driving 12-inch steel piles) we base our estimate of the impacts on a “typical” project that would include 10 piles. The USFWS analyzed the distance to the peak SPL and cumulative SEL injury thresholds for driving ten 12-inch steel piles. We chose 12-inch piles because they are the largest piles of the most common pile sizes for projects to be covered by SSNP. Given the assumptions above, underwater sound from the driving of ten 12-inch piles would exceed the injury thresholds at eight feet for $206\text{dB}_{\text{peak}}$, 241 feet for fish greater than or equal to two grams (187 SEL_{cum}). However, based on the expected distribution of bull trout within the action area, few fish are anticipated to be within a distance of impact pile driving events.

Impact pile driving will occur after vibratory pile driving options are exhausted per GCM# 6. In addition, impact pile driving will occur episodically throughout the in-water work window (July through February) when we expect bull trout numbers to be at their lowest within the Action Area, reducing the chance that individuals will be exposed to sound generated from pile strikes. Some individuals will experience sublethal effects, such as temporary threshold shifts and delayed foraging. Given the relatively low numbers of bull trout individuals distributed across the action area the total number affected will be low and concentrated around river estuaries. Despite the low likelihood of exposure, we cannot discount the possibility that bull trout will be within close enough proximity to impact pile driving events such that individual bull trout may experience injury, including injury that results in mortality.

Vibratory pile driving is not currently associated with injury or death to fishes or other aquatic organisms. This may be attributable to slower rise times (the time taken for the impulse to reach its peak pressure) associated with vibratory pile driving, and the fact that the energy produced is distributed over the duration of pile installation (WSDOT 2014). We anticipate that vibratory pile driving will cause only minor behavioral responses to bull trout and these behavioral responses are not expected to result in measurable effects or a significant impairment of their normal behaviors.

Impact pile driving will occur after vibratory pile driving options are exhausted per GCM# 6. In addition, impact pile driving will occur episodically throughout the in-water work window (July through February) when we expect bull trout numbers to be at their lowest within the Action Area, reducing the chance that individuals will be exposed to sound generated from pile strikes. Some individuals will experience sublethal effects, such as temporary threshold shifts and delayed foraging. Given the relatively low numbers of bull trout individuals distributed across the action area the total number affected will be low and concentrated around river estuaries. Despite the low likelihood of exposure, we cannot discount the possibility that bull trout will be within close enough proximity to impact pile driving events such that individual bull trout may experience injury, including injury that results in mortality.

Direct Handling or Salvage and Entrainment during Dredging

Some construction activities may require work area isolation and fish salvage to limit the impact and exposure to construction activities. The USFWS anticipates some level of work area isolation and therefore fish salvage may impact bull trout for projects located within lower rivers and estuaries. However, work area isolation in marine nearshore or along the marine shoreline is unlikely to impact bull trout individuals. In most cases, work area isolation in the marine nearshore or along the shoreline will occur in areas where bull trout are very unlikely to be present (i.e., in depths less than 2m) and can be conducted in a way to limit likely presence of bull trout, such as setting up barriers at low tide.

For work area isolation in estuaries and lower rivers, there is a greater likelihood of bull trout presence, especially during migrations between freshwater and marine habitats. Work area isolation can occur by temporarily diverting stream flow or using in-water isolation techniques such as placing a steel sleeve, driving sheet pile, or by placing a sandbag dam around the work area. These last three activities can occur without dewatering the streambed. When conditions allow (e.g., not during high flow events), fish can be excluded or removed from the work area through some or all of these methods: block nets, herding, seining, minnow traps, dip nets, and electrofishing. Nets, herding and seining methods will be used first on any work area isolation project (GCM #15) and are very effective at removing large fish from work areas. Given the size of bull trout expected in the action area (>150mm), these methods are expected to remove nearly all bull trout prior to the need for electrofishing.

The potential direct effects to bull trout from work area isolation in a stream or estuary include injury or mortality from stranding, impingement on fish screens or block nets, or entrainment into pumps. Other potential effects include delayed migration during the work period, disruption of rearing, and temporary loss of foraging. Adult and subadult salmonids likely present in the action area cannot seek refuge in the gravel and are easier to detect and herd out of the isolation area.

The potential effects to bull trout from work area isolation include harm from capture and relocation or from herding out of the project area. Capture and handling of fish causes a stress response, possible loss of the fish’s protective mucous coating, and potential injury or mortality from contact with nets or during electrofishing. Delayed responses may include increased susceptibility to parasites or disease from a stress-induced decrease in immune function and/or the loss of fish’s protective mucous covering. Additional delayed responses include missed feedings due to stress or injury, or delayed mortality from a handling injury. Because it is much easier to exclude larger fish from a work area, injuries or mortalities to subadult or adult bull trout due to fish handling are expected to be very low.

Electrofishing is typically used as a last resort to remove fish. The process involves passing an electrical current through water containing fish to stun them, making them easier to locate and remove from the work area. The process of running an electrical current through the water can cause a suite of effects on fish ranging from annoyance or fright behavior and temporary immobility to physical injury or death resulting from accidental contact with the electrodes. The amount of unintentional mortality attributable to electro-fishing can vary widely depending on the equipment used, the settings on the equipment, and the expertise of the technician. Because of their larger size and surface area exposed to the voltage, electrofishing can have severe effects on adult salmonids. Adverse effects include spinal hemorrhages, internal hemorrhages, fractured vertebra, spinal misalignment, and separated spinal columns (Hollender and Carline 1994; Dalbey et al. 1996; Thompson et al. 1997b). The long-term effects that exposure to electrofishing has on both juvenile and adult salmonids are not well understood.

Isolation of the work site has the obvious effect of temporarily removing individual fish from an area where they were exhibiting normal behavioral patterns and life histories. Such displacement can lead to higher energy expenditures by bull trout as they seek equilibrium and replace their previous feeding opportunity with a new one. The mechanical processes of using nets to move fish contributes to stress, although such short-term contact is less likely to cause injury or death. Handling stresses fish, increasing plasma levels of cortisol and glucose (Hemre and Krogdahl 1996; Frisch and Anderson 2000). Electrofishing can kill fish or cause physical injuries including internal hemorrhaging, spinal misalignment, or fractured vertebrae. Although potentially harmful to fish, electrofishing is intended to locate fish in the isolated work area for removal to avoid more certain injury. Ninety-five percent of fish captured and handled survive with no long-term effects, and up to 5 percent are expected to be injured or killed, including delayed mortality (USGS 2003).

Based upon the above information, the USFWS concludes that the adverse effects to adult and subadult bull trout from work area isolation include temporary displacement and take due to capture and direct handling. Due to their size adults and subadults generally cannot hide in the gravel and thus are easier to net, seine, or herd out of an isolation area. If they are still in the construction area during dewatering, they are easier to detect than juveniles and thus likely to be rescued with sanctuary nets. Conservatively, very few bull trout are expected within any one work area isolation zone.

Dredging will occur to remove sediments in order to maintain vessel access to docks, marinas, boat ramps, port terminals, industrial docks and wharfs, and outfalls for up to five projects annually and up to nine projects annually for small, site specific dredging at culverts and outfalls to maintain function of the culvert or outfall. It is possible that a bull trout within the area would be entrained (scooped up) during dredging operations, resulting in injury or death. As described earlier, there are relatively low numbers of bull trout distributed across the entire action area, and fewer are present during the anticipated work window of July through February.

Based on the relatively low presence of bull trout in the action area, the USFWS expects no more than one bull trout will be captured, handled, netted, or herded at any project involving work area isolation or entrained in any dredging operation. If we assume that one bull trout will be captured in all possible projects per year expected that may require bull trout salvage or handling or result in entrainment during dredging, up to 277 bull trout may be captured, handled or entrained annually, resulting in levels of disturbance sufficient to create a likelihood of injury. Based on a 5 percent injury/mortality rate, the USFWS expects that in-water work area isolation will result in the injury or death of approximately 14 bull trout per year.

11.2.4 Effects to Bull Trout from Water Quality Impairments

Stormwater Pollutants

Projects covered by this Opinion include the construction, repair and replacement of stormwater facilities and outfalls (PDC #3), and factors in several design criteria (PDC #13) to minimize the impact to listed bull trout and their forage. Stormwater and runoff from impervious surfaces can transport a variety of pollutants from dissolved metals to bacteria (McIntyre et al 2018, p. 197; Du et al 2017 entire; Spahr et al 2020 p. 15). Dissolved metals are particularly difficult to remove from stormwater.

Exposure to stormwater pollutants can cause reduced growth, impaired migratory ability, and impaired reproduction. The extent and severity of these effects varies depending on the frequency, timing, and duration of the exposure, ambient water quality conditions, the species and life history stage exposed, pollutant toxicity, and synergistic effects with other contaminants (EPA 1980; Harding et al 2020; Chow et al 2019). There are three known physiological pathways of metal exposure and uptake within salmonids: 1) gill surfaces can uptake metal ions that are then rapidly delivered to biological proteins (Niyogi and Wood. 2004), 2) olfaction (sense of smell) receptor neurons (Baldwin et al. 2003), and 3) dietary uptake. Of these three pathways, the mechanism of dietary uptake of metals is least understood. For dissolved metals the most direct pathway to aquatic organisms is through the gills.

Dissolved copper and dissolved zinc are the constituents of greatest concern because they are prevalent in stormwater, they are biologically active at low concentrations, and they have adverse effects on salmonids and other fishes (McIntyre et al 2012; Sandahl et al. 2007; Sprague 1968). Increased copper and zinc loading presents two pathways for possible adverse effects: direct exposure to water column pollutant concentrations in excess of biological effects thresholds; and indirect adverse effects resulting from the accumulation of pollutants in the environment over time, altered food web productivity, and possible dietary exposure.

Differences in species response to stormwater exposure has been recently observed in several studies. In coho, exposures to dissolved copper caused olfactory inhibition (Baldwin et al 2003; Sandahl et al. 2007) and exposures to undiluted stormwater runoff resulted in altered blood chemistry, behavioral changes including lethargy, loss of equilibrium, and immobility (McIntyre et al 2018 p. 199). However, chum exposed to similar undiluted stormwater runoff experienced less behavioral and blood chemistry changes (McIntyre et al 2018 p. 199). Zinc toxicity studies revealed effects including reduced growth, avoidance, reproduction impairment, increased respiration, decreased swimming ability, increased jaw and bronchial abnormalities, hyperactivity, hyperglycemia, and reduced survival in freshwater fish (Eisler 1993). Sprague (1968) documented avoidance in juvenile rainbow trout exposed to dissolved zinc concentrations of 5.6 μg/L over background levels. Rainbow and brook trout exposed to concentrations of 6PPD-quinone (found in tire rubber) exhibited similar behaviors as coho including mortality, gasping and hovering near the water surface and morbidity occurred between 1 and 7 hours depending on species (Brinkmann et al 2022 p. 337).

The proposed action includes 4 projects specific to stormwater outfall maintenance and repair projects will occur per year. However, many of the projects involving overwater structures, ramps, culverts and bridges will include some level of retrofit or stormwater treatment as an effect of the action, specified under PDC #3. The USFWS assumes these retrofits will meet state water quality standards and/or be operating within a state issued permit. We expect some projects which currently do not treat stormwater for their pollution generating impervious surface will retrofit to provide stormwater treatment in order to participate in SSNP. Treatment will not eliminate all pollutants in the post-construction runoff produced at project sites. Thus, adverse effects of post-construction stormwater runoff will persist for projects completed under SSNP.

During storm events, stormwater treatment facilities and outfalls will discharge treated stormwater. However, when design storm events are exceeded, the stormwater treatment facilities and outfalls may be overwhelmed and release untreated stormwater runoff. Contaminants are diluted when they are discharged into receiving waterbodies due to dispersion in the water column. To account for dilution of these pollutants at the point of discharge, a distance of up to 150 ft is assumed to be the extent that measurable effects to bull trout would occur. A distance of 150 ft is used because this is the distance at which State water quality standards must be met in marine and estuarine areas. Discharges that meet Washington Department of Ecology water quality standards may still contain pollutant levels that negatively impact bull trout. However, we anticipate that there is sufficient dilution within 150 ft of the proposed stormwater discharges to reduce the effects to bull trout such that they are not measurable beyond this zone. In addition, implementation of PDC #3 and PDC #13 will further reduce risks of exposure by bull trout to altered water quality from stormwater discharge.

Bull trout that pass within 150 ft of an outfall could be exposed to pollutants levels high enough to cause behavioral effects such as avoidance or olfactory inhibition or sublethal effects, such as reduced growth and impaired migratory ability. Based on Baldwin et al. (2003) and Sandahl et al. (2007) we assume a period of exposure between 30 minutes and 3 hours would be required to elicit behavioral or physiological responses in fish. Therefore, migrating adult and subadult bull trout transiting through habitat within this distance of outfalls would not likely be exposed long enough to sustain measurable effects. However, more sedentary forage species or juvenile salmonid species (including coho) may be exposed for longer periods, resulting in measurable impacts to survival, productivity and availability of forage resources. Over the 20-year analysis timeframe, this level of impact could result in altered forage resources available to bull trout. However, with implementation of stormwater treatment retrofits and new stormwater treatment facilities combined with the broad availability of forage species for bull trout, effects to forage resources resulting from exposure to stormwater pollutants are not expected to result in measurable effects to individual bull trout and are therefore insignificant.

Elevated Turbidity and Suspended Sediment

Construction of many of the activities covered under this programmatic may include sediment and substrate disturbing activities. Elevated turbidity and suspended sediment will affect bull trout, their habitat and forage species in the nearshore environment. Effects will be minimized through use of best management practices, installation of sediment curtains or isolation where possible, and minimization of total area disturbed to the extent possible; however, complete avoidance of sedimentation and turbidity increases is not achievable in most cases. We assume projects that include ground-disturbing activities adjacent to water, especially those involving in-water work, will likely result in suspended sediment above background levels.

The effects of increased suspended solids on salmonids depend on the extent, duration, timing, and frequency of increased sediment levels (Bash et al. 2001). Depending on the levels of these parameters, sedimentation can cause lethal, sublethal, and behavioral effects in juvenile and adult salmonids (Newcombe and Jensen 1996). Avoidance of turbid areas is the typical behavioral response, which can mean that bull trout are displaced from their preferred habitats in order to seek areas with less suspended sediment. Sublethal effects include reduction in feeding rates, reduced growth rates, stress, elevated blood sugars, gill flaring, and coughing (Berg and Northcote 1985; Servizi and Martens 1991; Spence et al. 1996).

Adult and larger juvenile salmonids appear minimally affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser 1991), indicating these species are adapted to withstand seasonal sediment pulses. However, research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Lloyd et al. 1987; Servizi and Martens 1991). We expect adults and subadults would leave areas with levels of turbidity high enough to impair respiration and feeding. Thus, they would be mostly affected by the effects of temporary displacement, rather than the direct effects of exposure to increased turbidity.

Pulses of elevated suspended sediment will occur episodically during the in-water work for individual projects. We cannot predict the number or duration of each pulse nor the number of individual fish that will be exposed to each pulse. We also cannot estimate the number of exposed individuals that will experience adverse effects from suspended sediment. Therefore, we will use a worst-case scenario, the physical extent of elevated turbidity (a habitat surrogate) to quantify the effects of elevated suspended sediment on bull trout.

Sediment delivery from the proposed activities will largely be temporary and localized in nature from destabilized areas, where soil and vegetation disturbance has taken place and will occur during precipitation events until new vegetation grows. Sediment production from pile driving will continue for only a short period (hours) after driving is completed and will occur only in a small area surrounding the pile being driven (in marine and estuarine areas (150 ft). We assume this is the likely area around any area of excavation and sediment disruption.

The USFWS anticipates most projects will result in some level of increased turbidity and suspended sediment. The effects of the 17 projects per year expected under PDC #14 Sediment Remediation are discussed separately in the *Contaminants* Section (11.2.4.3) below. We assume turbidity will extend up to 150 ft from any site-specific substrate disturbance. For example, a single pile installation could result in elevated turbidity or suspended sediment in an area up to 1.6 acres (area of a circle with a radius of 150 ft = 1.6 acres). Due to the proximity of piles in most structures, the affected area for each pile will overlap with the potentially affected areas associated with neighboring piles. This level of impact is assumed for all in-water substrate disturbances per location, including dredging. We cannot accurately predict the extent of potential turbidity impacts in the marine environment without knowing the size and number of projects. However, to account for short-term turbidity impacts in marine environments we assume each site-specific action would lead to sediment disruption or elevated turbidity in an area of 1.6 acres (150 ft circle). The USFWS expects elevated turbidity will dissipate quickly and settle shortly after the substrate is disturbed.

Bull trout are unlikely to experience measurable effects from these short-term substrate disturbances. In addition, early construction activity in an area will likely discourage bull trout presence in any one area. The low number of bull trout present and broadly distributed throughout the action area, particularly during the in-water work window of July through February, will further limit the likely exposure of bull trout to elevated turbidity during construction projects. Therefore, the effects of short-term and episodic construction related elevated turbidity in small site-specific areas combined with very low numbers of bull trout potentially exposed to elevated turbidity is not expected to measurably affect bull trout and will be insignificant.

Within the proposed action, there are fourteen dredging projects that may affect larger areas than described above. For these projects, quantities of dredged material provide a better surrogate for impacts to habitat. 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). These effects are in direct 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 PDCs require adequate testing of sediments prior to dredging to limit resuspension of toxic materials.

Dredging will occur to remove sediments in order to maintain vessel access to docks, marinas, boat ramps, port terminals, industrial docks and wharfs, and outfalls. To predict the likely level of activity and impact resulting from dredging to be carried out or permitted under SSNP, we consider the recent level of activity based on past individual consultations under the ESA. The average volume dredged under past projects considered was 6,715 cubic yards. The proposed project includes dredging for vessel access at 5 project per year. The USFWS expects no more than 33,575 cubic yards per year for vessel access dredging (PDC #9) or a total volume of 671,500 cubic yards over the foreseeable 20-year life of the proposed action.

The proposed project also includes minor dredging and clearing of materials for up to 9 projects per year. These projects represent small, site specific dredging at culverts and outfalls to maintain function of the culvert and outfall. The USFWS assumes no more than 50 cubic yards of material will be removed during any of these projects or 450 cubic yards per year.

During any dredging project, bull trout present would like experience measurable effects ranging from disturbance, behavioral changes, area avoidance, gill irritation and other non-lethal injuries, to entrainment (discussed earlier) and mortality from these operations. The number of bull trout individuals affected is expected to be relatively low, however, the unknown location and durations of dredging projects, the USFWS expects measurable impacts to the few bull trout present during vessel access dredging.

Contaminants

Contaminants may originate from stormwater runoff, pile removal and contaminated substrates. Stormwater related contaminants are addressed in the *Stormwater Pollutants* section above. Several other contaminants (creosote, polycyclic aromatic hydrocarbons or PAHs, etc.) to which bull trout may be exposed are associated with the removal of creosote and other piles, excavation of contaminated substrates and are addressed in this section. The extent of exposure is anticipated to be the physical extent of suspended sediment, which is described in detail above in the *Elevated turbidity and Suspended Sediment* section. The removal of contaminated substrates or creosote piling is anticipated to result in suspension of contaminants into the water column.

Creosote contains numerous constituents that are known to be toxic to aquatic organisms (Eisler 1987; Brooks 1997; Brooks 2000; Johnson et al. 2002). Creosote is composed primarily of PAHs (about 65 to 85 percent), with smaller percentages of phenolic compounds (10 percent), and nitrogen-, sulfur-, or oxygenated heterocyclics (Brooks 1997). Variations in physical and chemical characteristics of PAHs are generally related to molecular weight (Eisler 1987). With increased molecular weight, aqueous solubility decreases, solubility in fats increases, and resistance to oxidation and reduction decreases. Lower molecular weight (2 to 3 ring) PAHs are more mobile and can have significant acute toxicity to some organisms, whereas the higher molecular weight (4 to 7 ring) PAHs do not. However, all known PAH carcinogens, cocarcinogens, and tumor producers are in the high molecular weight PAH group.

Acute exposure to PAHs through the water or sediment can result in narcosis (Van Brummelen et al. 1998), suppressed immune function (Karrow et al. 1999), hormone disruption, and hepatic tumors in fishes (Krahn et al. 1986; Stein et al. 1990; Johnson et al. 2002). PAHs are ubiquitous in the marine environment and primarily originate from combustion products and petroleum (Meador et. al. 1995, Burgess 2009). The toxic effects of PAHs to aquatic species depends on several factors, including route of exposure, duration and concentration of exposure, chemical composition, organism sensitivity, life stage affected, organism potential for detoxification/excretion, and the physical condition of the particular organism during exposure (WDNR 2008).

Studies have shown that high concentrations of toxic chemicals in sediments are adversely affecting Puget Sound biota via detritus-based food webs (Johnson et al. 2002). Meador et al. (1995) provided a thorough review of the literature on factors governing the bioaccumulation of PAHs in marine invertebrates and fish. The study concluded that the major routes of exposure for marine species were through the uptake of waterborne chemicals and through the diet. Direct uptake of sediment-bound chemicals (e.g., through ingestion or absorption through the integument of worms and fish) appears to be negligible. Because PAHs tend to adsorb to sediments when sediment is undisturbed, only a portion of parent PAH compounds are readily bioavailable to marine organisms.

Overall, the laboratory and field studies indicate that creosote-treated wood structures can leach PAHs and other toxic compounds into the environment (Poston 2001). Chemicals in creosote break down in water very slowly. They tend to cling to particles of matter, making sediments the primary location for these contaminants to collect in aquatic environments (WDNR 2008).

Accumulation of PAHs in sediment is relatively limited spatially (within approximately 30 ft of structures) and has not generally been associated with measured, significant, biological effects except in close proximity or direct adhesion to the structures (Stratus 2006).

When sediments surrounding treated wood structures are disturbed, PAH compounds can potentially desorb into the water column and can be redeposited in surface sediments (Romberg 2005). Weston (2006) reported that during pulling of creosote pilings at the site of an old log yard operation, elevated PAH concentrations persisted for 5 minutes in the water column after the piles were pulled before returning to background levels. All measured water quality concentrations stayed below the Washington State standards of 300 parts per billion. Smith (2008) evaluated PAHs and phenols in sediments, timber, water, and oyster tissue before and after removal of creosote treated posts. Smith determined that PAHs in surface sediments increased from 24.1 mg kg-1 dry weight to 45.5 mg kg-1 dry weight after post removal and to 59.7 mg kg-1 dry weight 6 months later. He also determined that total PAHs (primarily low-molecular weight) dispersed to the environment when a creosote post was pulled out was at least 0.67 g.

Resident benthic organisms are exposed to PAHs through their diet, through exposure to contaminated water in the benthic boundary layer, and through direct contact with the sediment (Johnson et al. 2002). PAHs may bioaccumulate in aquatic invertebrates within these benthic communities (Varanasi et al. 1992; Meador et al. 1995). Bottom dwelling marine fish such as English sole, which feed on benthic invertebrate prey, could be exposed to high levels of PAHs. Most nonbenthic fish tissue contains relatively low concentrations of PAHs, and accumulation is usually short term because these organisms can rapidly metabolize and excrete them (WDNR 2008, Lawrence and Weber 1984, West et al. 1984 as cited in Eisler 1987). Generally, vertebrates quickly metabolize some of the lighter PAH compounds (McElroy et al. 1991). Once bull trout enter free swimming life stages in freshwater, when they are not closely associated with bottom sediments or enter an open-water marine life stage, the potential to be exposed to contaminants from treated wood at levels that adversely affect them is very low (Poston 2001).

The risk for exposure returns or increases when contaminants are resuspended as a result of pile removal and other in-water construction activities in the vicinity of treated wood structures. Given the expected presence of bull trout in the action area, the industrial history of marine and estuarine areas within the State, and the physical and temporal extent of turbidity and sediment effects described above in fresh and saltwater environments, we expect that bull trout in the action area will be exposed to elevated levels of contaminants and/or contaminated sediments as a result of proposed action activities. Given that toxic effects of PAHs and other contaminants to aquatic species depends on several factors, including route of exposure, duration and concentration of exposure, chemical composition, organism sensitivity, life stage affected, organism potential for detoxification/excretion, and the physical condition of the particular organism during exposure (WDNR 2008), it is difficult to accurately predict the direct or indirect effects to individual bull trout resulting from suspended or resuspended contaminants from pile removal activities. Therefore, we used the numbers of piles possible and volumes of sediment remediation that may be expected to determine the extent of possible effects to bull trout.

The estimated areas defined above represent the extent of short-term contaminant exposure resulting from project activities. We expect that contaminant resuspension resulting from pile removal activities within these areas will result in the disruption of respiratory functioning; endocrine development and functioning; and toxic effects to the liver, gastrointestinal system, blood, skin, immune system, nervous system, and reproductive system in adult or subadult bull trout. We expect that relatively low numbers of adult and subadult bull trout within the action area and extremely low numbers within a 150-foot radius of sediment disturbing project activities within marine and estuarine waters, would be exposed to water quality conditions resulting in adverse physical effects, including but not limited to the effects listed above. The placement of piles requires conservation offsets as part of the proposed action, which includes removal of creosote treated pilings. While short-term effects are expected from creosote treated pile removal from contaminants, the activity ultimately benefits bull trout through removal of a contaminant source in the long-term.

Temporary increases in contaminant concentrations within a 150-foot radius of sediment disturbing project activities in marine areas and estuarine habitats are not expected to disrupt normal bull trout behavioral patterns during periods of active in-water pile removal. The impact of suspended contaminants will extend up to 150 ft from a pile during pile removal activities, resulting in a maximum area of 1.6 acres of contaminant impacts per pile (area of a circle with a radius of 150 ft = 1.6 acres). As with the impacts of suspended sediment and turbidity, the USFWS expects effects of contaminants released during creosote piling removal will not measurably affect bull trout and will be insignificant. This is due to the low number of bull trout present and broadly distributed throughout the action area, particularly during the in-water work window of July through February, and the effects are short-term and episodic in small, site-specific areas.

Separately, another seventeen projects of sediment remediation per year are expected. The USFWS expects up to 14,875 cubic yards or less than 50 acres may occur per year for remediation projects (PDC #14). Due to the size and area of these remediation projects, the USFWS expects some adverse effects the result in short-term disruption of normal bull trout behavioral patterns, such as avoidance of foraging areas or reduced foraging within the affected area are expected from sediment remediation. Due the broad distribution at low numbers, few bull trout are expected to experience these affects. Over the long-term, the removal of contaminated sediments will improve habitat conditions for bull trout.

11.2.5 Overwater Structures

Permanent Overwater Structure

The proposed action includes installation or expansion of up to 79 in-water and overwater structures per year. In addition, the proposed action includes repair or replacement of 132 existing overwater structures per year and repair and replacement of culverts and bridges for fish passage. The total area affected by overwater and in-water structures each year is expected to be approximately 220,000 square feet based on project estimates with 50 percent consisting of new or expanded overwater structure. For all overwater structure construction, maintenance, replacement or repair, the proposed action requires conservation offsets to limit the long-term impact of the structures on the environment. In-water and over water structures impact bull trout and their forage through long-term increased activity, increased risk of predation, migration barriers, and altered habitat function. Overwater and in-water structures affect the ability for natural habitat processes that provide for the shelter and security of forage species.

Expansion or installation of new structures is expected to lead to increased boat, vessel and human activities. Increased background noise has been shown to increase stress in fish (Mueller 1980; Scholik and Yan 2002a; Scholik and Yan 2002b; 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 sources (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 responses from exposure to the sound generated by recreational boating activities. 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. Researchers have also observed fish exhibiting decreased response to predation threats and increased ventilation in response to short playbacks of ship noise, although fish largely recovered within 2 minutes of the exposure (Bruintjes et al. 2016, p. 8-12). While the USFWS anticipates some level of increased activity within the action area associated with up to 79 new or expanded overwater and in-water structures per year, there is limited information to determine the full effect on bull trout foraging in the marine and nearshore environment. We anticipate that some startle or area avoidance may occur at busy or active facilities, but that the effects to bull trout of this impact would not be measurable over the existing conditions within the Salish Sea.

In addition, overwater structures result in altered predator prey relationships, specifically for forage fish species. For forage species, such as juvenile salmon, overwater structures expose them to increased piscivorous predation. Several studies over the last 15 years show that 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). Juvenile salmon, in both the marine nearshore and in freshwater, migrate along the edge of shadows rather than through them (Nightingale and Simenstad 2001; Southard et al. 2006; Celedonia et al. 2008a; Celedonia et al. 2008b; Moore et al. 2013; Munsch et al. 2014). Typical piscivorous salmonid predators, such as flatfish, sculpin, and larger salmonids like bull trout, generally avoid the shallowest nearshore waters that outmigrant juvenile salmonids prefer—especially in the earliest periods of their marine residency. When juvenile salmonids leave the of the shallow water to move around the shadows created by overwater structure, their risk of being preyed upon increases. Bull trout are not typically associated with nearshore structure (often further than 100m from shore) and generally found in water depths greater than 2 meters. Because of this, the USFWS expects that overwater structures likely bring more foraging opportunities to bull trout, being larger opportunistic feeders out in deeper waters. There is currently no evidence that suggests overwater structures hinder bull trout behaviors or increase the risk of predation. Given activity around structures and general distribution of bull trout in the action area, the USFWS does not expect measurable impacts to bull trout individuals from the new or expanded overwater structures.

11.2.6 Altered Forage Conditions

Installation of 79 new or expanded overwater structure or 132 repair, maintenance or replacement of existing structures, as well as shoreline modification projects may result in long terms impacts to habitat of bull trout forage species. The USFWS estimates based on past and expected project numbers that the total area affected by overwater structure will be 220,000 square feet and approximately 50 percent or 110,000 square feet annually will consist of new overwater structure (Table 7). In addition, the USFWS anticipates up to 24,000 linear feet of shoreline modification to occur (Table 7). Repair and replacement of existing overwater structure and shoreline modifications are expected to hinder the restoration or improvement of existing degraded forage resource habitat function in the action area, but we do not expect these projects to remove existing fully functioning habitat. However, new or expanded overwater structure and shoreline modifications are expected to have a greater impact on forage resource habitat function through the removal or degradation of existing functioning habitat.

Submerged aquatic vegetation provides crucial habitat in the form of cover and a food base for forage fish and juvenile salmonids, which are prey resources for bull trout. When submerged aquatic vegetation (SAV) is shaded the primary productivity is reduced, especially if the vegetation does not receive the light it needs to survive. Additionally, the area affected by the proposed action likely extends beyond the immediate footprint of a structure.

Spawning areas for Pacific herring are largely limited to depths where submerged aquatic vegetation can grow; Pacific herring also use several other species of macroalgae for spawning. In shallower areas, *Zostera marina* is of primary importance, and in slightly deeper areas, *Gracilaria* spp. predominates (Penttila 2007). Other types of submerged aquatic vegetation used for spawning by Pacific herring include “algal turf,” often formed by dozens of species of red, green and brown algae, (Penttila 1973). In deeper water and in areas where native eelgrass beds do not predominate, herring spawn on the mid-bottom-dwelling red alga *Gracilariopsis* sp. (referred to as Gracilaria in some sources) (Penttila 2007). There are few species of marine macro-vegetation that can tolerate the reduction in ambient light within the direct footprint of a typical overwater dock or pier. Additionally, herring eggs deposited on wood pilings associated with overwater structures may be impacted by contaminants and higher risk of thermal shock and desiccation of eggs. New overwater structures can also impact other forage fish spawning habitat (i.e., Pacific sand lance and surf smelt) by introducing propwash scour and reducing input of sediment by changing the drift cell pattern.

Piers, ramps and floats (PRF) and the boats associated with them shade intertidal habitat. New floats are generally grated, but boats and floating boat lifts are not; floating boat lifts can create more shade than the PRF or lift structures do depending on their size. The additional shading from the boat lifts and boats reduces the light transmission to aquatic vegetation that provides refuge for some spawning forage fish (i.e., Pacific herring). There are few studies that specifically examine the effect of overwater structures on submerged aquatic vegetation types other than eelgrass and kelp (Mumford 2007). Fresh et al. (2006) researched the effects of grating in residential floats on eelgrass, one matrix upon which Pacific herring spawn, and reported a statistically significant decline in the density of eelgrass shoots under most floats studied in northern Puget Sound. The physiological mechanism that reduces shoot density and biomass associated with shading applies to all types of submerged aquatic vegetation because of their universal need for adequate light transmission to survive. Reductions in submerged aquatic vegetation are expected to reduce the primary production of the various types epibenthos present (Haas et al. 2002).

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 overwater structure (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 eggs provide forage for bull trout. Over time, the incremental reduction in epibenthic prey associated with OWS is expected to reduce forage species production and populations.

Many studies suggest that overwater structures can disrupt migration of juvenile salmonids in the Puget Sound nearshore. Swimming around structures lengthens the salmonid migration route, which can increase mortality. In the Puget Sound nearshore, 35 millimeter to 45 millimeter juvenile chum and pink salmon were reluctant to pass under docks (Ono et al 2010 p.5). 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. Ono (2010) reports that juveniles tended to stay on the bright side of the shadow edge, two to five meters away from the dock, even when the shadow line moved underneath the dock.

The adverse effects of the proposed action on juvenile salmonids and other prey resources for bull trout will occur at various locations proposed action in perpetuity. Bull trout prey resources will be exposed to the measurable, persistent, and long-term effects associated with the repair, replacement and installation and use of overwater structures and the long-term alterations of shorelines. These effects include changes population, recruitment, and densities of prey resources dependent on free migration in the nearshore or the presence of SAV for expression of their life histories. The effects will be broadly distributed throughout the action area and will affect bull trout through changed or altered densities, availability, and distribution of prey resources over the long-term. The repair and replacement of existing overwater structure will result in continued degraded conditions of habitat function for forage species. This impact will be prolonged by repair and replacement of existing structures. New and expanded overwater structure, especially in areas of eelgrass beds, will result in the loss of existing fully functioning habitat and increasing the overall area of degraded conditions within the action area. Over the anticipated implementation of this programmatic consultation (20-years), the accumulated loss of habitat function from the proposed activities could significantly increase declines in forage species diversity and availability for bull trout.

However, the proposed action includes implementation of conservation offsets that are expected to reduce the overall impact of habitat function loss from overwater structures and shoreline modifications. Activities resulting in habitat function loss are required to provide evidence of conservation offsets equal to or greater than the anticipated area affected. Conservation offsets will result in removal of contaminant sources such as creosote pilings, shoreline and riparian habitat restoration, removal of derelict structures as well as other actions that, once implemented, will provide improvements of habitat function, primary productivity, and habitat availability for forage species. The USFWS expects that the restoration and conservation offset projects will take time to provide equivalent function as those lost due to new or expanded overwater structure or shoreline modifications. Therefore, short-term changes to forage resources are expected, but in the long-term, bull trout prey diversity and availability will increase.

Bull trout forage in the marine environment is not considered limiting due to their propensity for opportunistic feeding. Overwater and shoreline structure will result in measurable impacts to forage fish species (specifically herring and juvenile salmon) both in the short-term and long-term. Altered availability and dependence on other species that are more available (i.e., pink salmon, flatfish, sculpin) will result in a changed diet for anadromous bull trout, but not measurably change the health or fitness of individuals. Over the long-term, the implementation of restoration actions and conservation offsets in the action area are expected to improve habitat function and in relation, improve diversity and densities of forage species for bull trout.

11.2.7 Effects To Bull Trout Critical Habitat

The nearshore marine environment in Puget Sound and the Strait of Juan de Fuca were designated as bull trout critical habitat on October 18, 2010 (75 FR 63898). The nearshore areas are used by anadromous bull trout for foraging and migration. The Environmental Baseline section of this Opinion describes how human alterations such as bank armoring, removal of shoreline vegetation, development, and surface runoff have affected many of the primary constituent elements and are compromising the function of critical habitat. Refer to Appendix D for a discussion of the Rangewide Status of Bull Trout Critical Habitat. The proposed project is anticipated to result in insignificant, adverse and beneficial effects to designated critical habitat. Some elements of the proposed action will further degrade the baseline conditions while the conservation offsets will minimize impacts to, and even lead to some improvement in baseline conditions. As such the proposed action will result in both adverse and long-term beneficial effects to the following PCEs in the action area:

PCE 2: Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

As noted in the Environmental Baseline section, this PCE is functioning at risk within the action area. In some areas of lower tributaries and estuaries, passage barriers from dams, culverts and bridges impair migration habitat for bull trout. However, throughout much of the marine and marine influenced areas, migration habitat is generally unimpeded.

Several elements of the proposed action will result in short-term impacts to migratory habitat throughout the action area. Construction related effects from elevated sound and human activity during pile driving and substrate disturbances that elevate turbidity and suspended sediments are expected to result in short term adverse impacts to this PCE such as migration direction changes or area avoidance. However, given the relatively short duration of these impacts, no long-term changes to migration habitat, and the continued access to migratory habitats throughout the action area, these effects are not expected to measurably effect the overall ability of the action area to provide migration habitat for bull trout. As such, the effects related to construction elements of the proposed action on this PCE are considered insignificant.

However, the permanent repair, replacement, and installation of overwater structures and shoreline armoring are likely to adversely affect this PCE in the immediate vicinity of structures. While the structures themselves adversely affect migration patterns of juvenile salmon and other forage species, the structures are not known to impact bull trout migration in the marine environment as they are typically using areas in deeper waters. Forage species adversely affected by the installation and repair/replacement of overwater structures are expected to decline or the composition of species changes as a result of the permanent structures in place. Therefore, the quality and availability of foraging migration habitat is expected to decline or be reduced in areas impacted with new or expanded overwater structures and shoreline armoring. We anticipate that up to 24,000 linear feet of shoreline armoring may be installed or repaired and up to 110,000 square feet of overwater structures may be installed or expanded each year under the proposed action (Table 7). While this impact is spread across the entire action area, the majority will occur within existing degraded areas near urban areas in Central and South Puget Sound, Everett, and Port Angeles/Port Townsend. Overall, it will not preclude the use of habitat for bull trout but will reduce the quality of the habitat.

The proposed action includes conservation offsets that are intended to reduce the impact of altered habitat from overwater structures and nearshore habitat quality degradation. Conservation offsets include on-site and off-site enhancements such as riparian plantings, placement of forage fish spawning gravel, installation of large woody material, removal of pilings, removal of existing overwater structures, removal of bank stabilization, removal of boat ramps and rails, removal of manmade groins and purchasing of credits from third-party mitigation sources. The benefits of these conservation offsets across the entire action area are expected to minimize for the overall impact to habitat function from installation of overwater structure and shoreline modifications. While localized impacts to this PCE will occur, over the duration of the action, with consideration of the conservation offsets, we expect that these impacts will be relatively minor.

Overall, the effects of the proposed action to this PCE will not preclude bull trout from moving through the area. The addition of new overwater structure will adversely affect the quality of this PCE particularly in areas where migration habitat is well functioning. Implementation of the conservation offsets will ameliorate many of the effects to this PCE at the scale of the action area. Therefore, long-term elements are not expected to measurably alter this PCE within the action area. Short-term impacts to this PCE from construction activities are not expected to result in measurable impacts to the migratory corridor (i.e., elevated sound, elevated levels of turbidity and/or contaminants) and are therefore insignificant.

PCE 3: An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

As noted in the Environmental Baseline section, this PCE is functioning at risk in the action area. Nearshore marine areas in the action area provide important spawning habitat for forage fish species such as Pacific herring, Pacific sand lance, and surf smelt and migration, foraging and rearing areas for juvenile salmonids. Across most portions of the action area, both salmonid and marine forage fish prey resources are well below historic, long-term peaks of production. However, some areas where restoration actions are occurring (i.e., Hood Canal, Elwha River), forage resources are improving.

In- and over water structures, shoreline armoring, as well as in-water work that disturbs substrates or results in elevated sound all have the potential to alter the diversity or physically disturb, displace or kill bull trout forage species. Permanent structure installation in nearshore habitat is anticipated to increase shading of submerged aquatic vegetation. Increased shading from installing overwater structures in nearshore habitat can result in measurable impacts to the behavior of juvenile salmonids or other forage species as well as increased predation on them. Increased shading is also expected to reduce the quantity of submerged aquatic vegetation and impact the abundance of Pacific herring, invertebrates and other species that require that habitat. The total degree of impact to forage species and their habitat is difficult to quantify as it depends on the localized baseline habitat conditions where a structure is built and the successful implementation of minimization measures limiting the area affected. The USFWS assumes up to 220,000 square feet of overwater structure may be repaired, replaced or installed in a given year. Approximately half of this total is expected to be repairs or replacement of existing structures occurring in existing degraded habitats. The other half or 110,000 square feet each year will be new or expanded overwater structure. New or expanded overwater structure is most impactful to forage resources because the installation of new overwater structure removes existing functioning habitat that is currently limiting in the action area.

As described earlier, conservation offsets are intended to reduce the impact of altered habitat from overwater structures and nearshore habitat quality degradation through replacement of habitat values and functions. These activities include within and outside of basin actions that will increase floodplain connectivity, remove derelict and contaminated structures (i.e., pilings, vessels, overwater structure), and improve forage resource productivity. Conservation offsets include on-site and off-site habitat benefits to reduce the overall impact of project activities on forage resources and their habitats in the action area as a whole. The benefits of conservation offsets are expected to take time to be fully realized and lead to improved conditions for forage species habitat in the action area. Over the assumed 20 years of program implementation,, these benefits are expected to equal or surpass the impacts occurring from the installation of new structure.

In addition to the permanent changes to the function of this PCE within the action area, we expect short-term measurable impacts to forage resources from changes to water quality, elevated sound, and substrate disturbances associated with in-water, nearshore, and shoreline construction activities. Forage fish species, juvenile salmonids, and macroinvertebrates will experience variable levels of construction related impacts from short-term displacement to mortality. These impacts, while measurable in the short-term during construction, will not permanently change the function of this PCE. As construction ceases and habitat returns to pre-construction conditions, forage resources are expected to recolonize the affected area immediately.

As described earlier, conservation offsets are intended to reduce the impact of altered habitat from overwater structures and nearshore habitat quality degradation. Conservation offsets include on-site and off-site habitat benefits to reduce the overall impact of project activities on forage resources and their habitats in the action area as a whole.

Therefore, we expect short-term reduced function of forage areas during construction activities and, and absent the conservation offsets, long-term significant impacts from permanent structures that alter, degrade or remove forage species habitat. The implementation of conservation offsets in conjunction with many projects will improve habitat conditions in areas across the action area. Therefore, we anticipate the overall function of this PCE within the action area to be maintained in its current condition in the long-term.

PCE 4: Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

As noted in the Environmental Baseline section, this PCE is not properly functioning. At some locations, where armored and hardened shorelines, fill, and overwater structures are more pervasive, and where important natural processes that create and maintain functional nearshore marine habitat are impeded, this PCE is severely impaired.

The proposed action includes installation of permanent structures in-water, over-water, and along the shorelines of the action area. These structures are expected to alter natural tidal functions, including drift cell patterns, limit wood recruitment in estuaries and along shorelines, change or alter sediment distribution, and change or modify aquatic vegetation and cover. Processes that create and maintain complexity, such as natural sediment recruitment, and varieties in depths, gradients, and substrate size will continue to be degraded over the long term with dredging activities and construction of overwater and shoreline structure.

Proposed conservation offsets may minimize or reduce some of these impacts, as well as implementation of beach nourishment, and other habitat enhancement projects in PDCs #1, #11, #12, and #13. However, the USFWS still anticipates up to 220,000 square feet of overwater structure will be repaired, replaced, or constructed in a given year. In addition, 24,000 linear feet shoreline armoring may be replaced, repaired, or added and vessel navigation channels will continue to be dredged. While some conservation offset projects will include actions that improve habitat complexity in the action area, such as floodplain connectivity projects and shoreline armoring removal, not all conservation offsets will replace the complex habitat function lost through altered shoreline processes (i.e., bank armoring) and overwater structures. Therefore, these impacts will continue to degrade habitat complexity in foraging areas for bull trout throughout the Salish Sea. The USFWS expects continued and ongoing adverse effects combined with conservation offsets will maintain the existing degraded function of this PCE in nearshore and estuarine areas. Over the 20-year timeframe of the proposed action, as conservation offsets improve shoreline function throughout the action area, the degraded function of this PCE will improve in targeted areas.

PCE 8: Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

As noted in the Environmental Baseline section, water and sediment quality conditions are generally suitable and adequately functioning, though some portions of the action area exhibit mild or moderate impairment.

Construction activities will result in temporary changes to water quality from elevated turbidity, suspended sediment, and release of contaminants during in-water and substrate disturbing activities. The impacts of water quality will be short-term and are not expected to result in long-term changes in the function of this PCE in foraging and migratory habitat of bull trout. There will be no impacts to elements of this PCE to spawning and rearing areas for bull trout and no change to water quantity within the action area. The USFWS anticipates impacts to water quality from contaminants may occur from stormwater discharge or from the release of creosote during removal of treated-wood piles. However, these effects will be minimal because of their localized nature, and overall, the effects to water quality will be an improvement over existing conditions. The proposed action requires treatment of stormwater for projects that increase impervious surface. Therefore, as stormwater treatment facilities are retrofitted and/or constructed, water discharged to water bodies from impervious surfaces will contained reduced contaminant content. The removal of creosote pilings, while releasing contaminants during removal, will ultimately remove a permanent contaminant source from the water upon construction completion.

Contaminant concentrations may increase in marine waters from the increased use of watercraft (PAHs) and installation of ACZA-treated wood piles. Water quality will also be temporarily impacted during the installation of mooring buoys, overwater structures, piles, and other permanent features from elevated levels of turbidity. These effects will be temporary and no measurable long-term effects to habitat are expected from the proposed activities. We anticipate the release of these materials will be intermittent, infrequent, and limited to very small quantities (ounces) and localized areas. Overall, we expect the water quality impacts to be very minor in magnitude. Therefore, we do not expect the proposed action would measurably affect this PCE and the existing function of this PCE will be maintained.

11.2.8 Summary of Effects for Bull trout and Bull trout Critical Habitat

Effects to bull trout and their critical habitat are anticipated from several elements of the proposed action. In most cases, adverse effects are of short-duration and related to immediate impacts of construction of activities authorized under the proposed action. Short-term adverse effects of the action on bull trout are expected from impacts water quality, elevated underwater sound and human activity, altered forage base, and consequences of direct handling of bull trout. These short-term impacts have the potential to alter individual bull trout behavior, limit foraging opportunities, and in the case of handling or elevated sound from pile driving, lead to injuries sufficient to result in mortality. It is difficult to quantify the specific number of bull trout that may be affected by construction activities. However, these short-term effects are expected to impact few bull trout individuals each year. The USFWS expects the low number of bull trout affected based on the large geographic area of the proposed action, low numbers of bull trout distributed across the action area from several different core areas, the timing of bull trout use of the action area, and the likelihood that bull trout will avoid areas of elevated activity and disturbance.

During the months of marine residency (April through July), bull trout are more common and broadly distributed. In the non-residency period (August through March), the number of bull trout drops significantly. In North Puget Sound, we expect as many as 1,750 bull trout individuals from four Core Areas will be distributed between Canada, San Juan Islands and Central Puget Sound during marine residency. This total reduces to approximately 350 individuals through the rest of the year. In Central and South Puget Sound, approximately 700 bull trout from two Core Areas occur during the marine residency and fewer than 150 the remainder of the year. The anticipated number of bull trout individuals in Hood Canal and the Strait of Juan de Fuca are very low. Only bull trout from the Skokomish Core Area are expected in Hood Canal at numbers below 50 at any time of year. The number of bull trout individuals from the Dungeness and Elwha Core Areas will range from 300 down to approximately 60 throughout the year. However, given restoration actions that have led to improved populations in the Elwha Core Area, these totals are expected to increase into the future. For any one project, the USFWS expects that fewer than 5 bull trout from any one Core Area would experience short-term effects from construction.

In addition to short-term construction effects of the action, the USFWS anticipates that over the long-term the proposed action will result in altered conditions of the habitat across the action area. Up to 220,000 square feet of overwater and in-water structures (with assumed on-going effects for 40-50 years) are expected to be replaced, repaired or constructed each year of the implementation of SSNP where as much as half of this total will be new overwater structure. The proposed action will also include up to 24,000 linear feet of shoreline and up to 33,575 cubic yards of dredging for vessel access each year. These effects will result in long-term significant adverse effects to forage species and their habitat resulting in adverse effects to bull trout individuals. Over time the implementation of conservation offsets are expected to improve habitat function for forage species, and therefore improve forage conditions for bull trout.

The proposed action occurs within bull trout critical habitat. Four PCEs for bull trout critical habitat are present in the action area: PCE#2 migration corridors, PCE #3 forage resources, PCE #4 complex habitat, and PCE#8 water quality and quantity. Over the assumed 20-year implementation of the SSNP framework, the USFWS expects short-term construction related adverse effects to water quality (PCE#8) and migration (PCE#2). These effects are not expected to reach levels altering the function of these PCEs into the future. However, long-term adverse effects to forage resources (PCE#3), complex habitat (PCE#4) and to a lesser extent migration (PCE#2) are expected from the proposed action. These effects are expected primarily from the installation, repair, and replacement of overwater, in-water, and shoreline structure that alters the natural habitat forming processes adequate for forage resources. The level of affected area is expected to match the areas described for bull trout individuals above including up to 220,000 square feet of overwater and in-water structures, up to 24,000 linear feet of shoreline, and up to 33,575 cubic yards of dredging. The implementation of conservation offsets included in individual project activities as well as habitat improvement projects such as beach nourishment (PDC #14), culvert and bridge replacements (PDC #1), habitat enhancement activities (PDC #11) and levee setbacks or removals (PDC #12) are expected to minimize the long-term impacts of overwater, in-water, and shoreline structures and vessel access dredging, especially with impacts to forage resources. For forage resources PCE #3, the implementation of conservation offsets will improve the conditions over time. However, long-term and ongoing degradation of habitat complexity (PCE #4 of critical habitat) is expected, maintaining the degraded condition of this PCE in the action area.

11.3 Marbled Murrelet

The proposed action is expected to result in insignificant, adverse and beneficial effects to marbled murrelet. Most of the activities covered under this programmatic Opinion may result in potentially significant effects to water quality, substrate condition, physical habitat structure and function, benthic/epibenthic community structure and composition, and predator-prey dynamics. For this Opinion, the effects of the action that may result in measurable impacts to marbled murrelet or their habitat will be categorized and analyzed by direct impacts to individuals from exposure to elevated sound or and altered forage conditions.

11.3.1 Direct Impacts to Marbled Murrelet Individuals

Effects of Elevated Sound Levels in Suitable Nesting Habitat

Very small areas of suitable nesting habitat may be found within or adjacent to project areas. The average terrestrial marbled murrelet density estimated for Washington is 189 acres per marbled murrelet (Raphael et al. 2018, p. 315, 317). This estimate represents all age classes, including breeding and non-breeding birds. In a recent population viability model developed to explore the relationship between marbled murrelet populations and nesting habitat in Washington, the model best matched current population dynamics when it was assumed that breeding adults make up only about 40 percent of the total marbled murrelet population in Washington, while the remainder of the population are juveniles and non-breeding adults (Peery and Jones 2019, p. 25-26). By this calculation, we would expect 1 breeding adult per 500 acres, and 1 nest per 1,000 acres. Marbled murrelets are most likely to nest within 5 km of other marbled murrelet nests so we anticipate nesting to be somewhat clustered in suitable nesting habitat and to be unlikely to occur in areas where suitable nesting habitat is highly fragmented (Meyer et al. 2002, p. 103). We anticipate most projects will occur in previously developed areas that are not within proximity to suitable nesting habitat. Nesting occurs in Washington between May and September with approximately half of chicks fledging by July 15 (Hamer and Nelson 1995). The timing of the proposed action in accordance with current in water work windows will reduce the likelihood of exposure. We expect the likelihood of a project occurring within 8,900 feet of occupied nesting habitat to be small.

Observations of marbled murrelet responses to other sources of noise disturbance at nest sites have primarily been modifications of posture and on-nest behaviors indicating alerting, without flushing or abandoning the nest (Hébert and Golightly 2006, pp. 35-39; Long and Ralph 1998, p. 22). Hébert and Golightly (2006) monitored nesting marbled murrelets exposed to experimental bouts of chainsaw noise and the presence of people hiking on trails in Redwood National and State Parks in northern California. Adult and chick responses to chainsaw noise, vehicle traffic, and people walking on forest trails resulted in no flush responses. However, adults exposed to chainsaw noise spent more time with their head raised, and their bill raised up in a posture of alert, vigilant behavior. When undisturbed, adult marbled murrelets spent 95 percent of the time resting or motionless (Hébert and Golightly 2006, pp. 35-39).

Marbled murrelet chicks exposed to chainsaw noise also spent more time with their head raised, and their bill up during the disturbance trials, although compared to pre- and post-disturbance trials, the relationship was not statistically significant (Hébert and Golightly 2006, p. 36). The relevance of the behavioral responses seen in adults tending nests is unknown, but the behavior is similar to an adult marbled murrelet reaction to the presence of a nest predator (Hébert and Golightly 2006, p. 35). The authors suggest that marbled murrelets responding to a noise by moving or shifting position would increase the chance that it will be detected by a predator. Additionally, the energetic cost of increased vigilance to protracted disturbance could have negative consequences for nesting success (Hébert and Golightly 2006, p. 37).

Adult marbled murrelets typically feed their chicks in the early morning and in the evening. Exposure to loud noise while an adult approaches a nest to provision a chick may cause sufficient disturbance to result in abortion or delay of the feeding. Hamer and Nelson (1998, p. 9) noted that adult marbled murrelets would abort feeding attempts or flush off the nest branch during attempted food deliveries when people on the ground were visible to the birds and within a distance of 15 to 40 m, or occasionally when vehicles passed directly under a nest tree.

Marbled murrelet chicks appear to be much more unlikely than adults to respond in a way that is visible to observers, and there are no documented instances of a nestling marbled murrelet falling due to sound or visual disturbance, including disturbances due to researchers climbing nest trees, handling young, and placing cameras close to young (USFWS 2003, p. 269). Marbled murrelets have evolved several mechanisms to avoid predation; they have cryptic coloration, are silent around the nest, minimize movement at the nest, and limit incubation exchanges and chick feeding to occur mainly during twilight hours (Nelson 1997, p. 14). Hébert and Golightly (2006) suggest that flushing as a result of a noise disturbance might not provide a benefit compared to the potential risk of exposure to predators. When confronted with the presence of potential predators, marbled murrelets remain on the nest in alert or defensive postures (Hébert and Golightly 2006) and are reluctant to flush unless confronted directly by a large predator such as a raven (Singer et al. 1991).

The best available information regarding marbled murrelet use of its habitat within the action area indicates that there is little available nesting habitat for marbled murrelets within the action area. Therefore, exposure of chicks and adults in nests to noise disturbance is expected to only rarely occur. Based on the best available information concerning marbled murrelet responses to disturbance associated with noise, activity, and human presence, we draw the following conclusions for rare instances where marbled murrelet nesting areas are subject to noise disturbance:

> Adult marbled murrelets are most likely to exhibit a flush response while attempting to deliver food to the chick at dawn or dusk. Pile installation is anticipated to be the largest source of sound disturbance caused by the proposed action. Pile installation within 2 hours of dawn and 1 hour of sunset are not included in the proposed action so we do not anticipate flush responses at dawn or dusk to occur.
>
> Adult marbled murrelets that are incubating an egg are not likely to flush from noise disturbance alone. The only observations of flushes during incubation involved a direct approach to the nest by a researcher or a predator such as a raven.
>
> The normal behavior of incubating adults is to rest and remain motionless during the day. Noise disturbance can disrupt this normal behavior by causing the adults to remain vigilant and alert during a time when they are normally resting. Noise disturbance from pile driving is expected to be intermittent and short and is not anticipated to cause long periods of increased vigilance.
>
> Marbled murrelet chicks appear to be mostly unaffected by visual or noise disturbance. The greatest risk to marbled murrelet chicks from disturbance is the potential for missed feedings, which occur primarily during dawn and dusk periods, but do occasionally occur during mid-day hours.
>
> Marbled murrelet nesting in close proximity to the nearshore environment are expected to have less energetic constraints due to their proximity to foraging habitat in comparison to other marbled murrelets in the action area.

We expect the likelihood of exposure of nesting marbled murrelet to noise disturbance from the proposed action to be low due to the small amount of suitable nesting habitat adjacent to the nearshore in the action area. Marbled murrelet may remain vigilant and alert at a time when they are normally resting if exposed to noise disturbance or exhibit a flush response if a prey delivery coincides with a noise disturbance. Due to the intermittent and brief nature of pile driving, lost rest is not expected to result in measurable effects to marbled murrelet. With GCMs in place to reduce the likelihood of noise disturbance resulting in a flush response during prey delivery, we expect the behavioral response to be rare. Should a flush response during prey delivery occur, it is not expected to result in measurable effects due to the close proximity of a nesting marbled murrelet adjacent to nearshore habitat to forage resources. Considering all of the above factors, we expect insignificant effects to nesting marbled murrelets and chicks from noise disturbance.

Effects of Elevated Underwater Sound Pressure Levels

Effects to marbled murrelets from exposure to elevated underwater sound pressure levels could range from minor behavioral changes to injury and/or death. In the absence of data specific to seabirds, we use evaluations of the effects of other types of similar underwater sound on a variety of vertebrate species. We use this data as the basis for evaluating the effects of high underwater sound generated by pile driving on marbled murrelets. High levels of underwater sound have resulted in negative physiological and neurological effects on a wide variety of vertebrate species (Yelverton et al. 1973; Yelverton and Richmond 1981; Gisiner et al. 1998; Hastings and Popper 2005). Experiments using underwater explosives found that rapid change in underwater SPLs caused internal hemorrhaging and mortality in submerged mallard (*Anas platyrhynchos*) (Yelverton et al. 1973, p. 49). During seismic explorations, seabirds were attracted to fishes killed from seismic work (Fitch and Young 1948, p. 56; Stemp 1985, p. 228). Fitch and Young (1948, p. 56) found that diving cormorants were consistently killed by seismic blasts, and pelicans were frequently killed, but only when their heads were below water.

Injuries from exposure to high underwater sound levels can be thought of as occurring over a continuum of potential effects ranging from a threshold shift in hearing to mortality. A threshold shift in hearing includes impaired or lost hearing. A threshold shift may be either temporary or permanent, depending on a number of factors, including duration pressure and loudness of the sound (USFWS 2012a, pp.8-9). The USFWS expects that the onset of injury (hair cell loss, or in other words auditory injury) would occur at $202\mathrm{dB}_{\mathrm{SEL}}$. This hair cell loss can be temporary or permanent, depending on exposure level. The severity of a threshold shift depends upon several factors such as the sensitivity of the subject, the received SPL, frequency, and duration of the sound (Gisiner et al. 1998, p. 25).

Threshold shift in birds was studied within lab settings by Ryals et al. (1999) and in pinnipeds by Kastak et al. (2005) revealing that threshold shift increased more in response to an increase in duration than an increase in SPL. Birds tested under these lab settings generally demonstrate greater tolerance to high SPLs than other taxa. Although these findings are not completely understood, there is general agreement that 1) considerable variation occurs in individual responses, within and between species, 2) hearing loss occurs near the exposure frequency (Hz) in organisms (for narrow-band sound), and 3) hearing loss becomes irreversible under some combination of sound pressure level and exposure time, even in birds (Saunders and Dooling 1974, p. 1; Gisiner et al. 1998, p. 25; Ryals et al. 1999).

Due to a lack of data specific to seabirds, the USFWS convened an expert panel (SAIC 2011) that relied on data from other vertebrate species to draw conclusions about levels of effect and thresholds for use in evaluating the extent of those effects. For estimating the expected onset of hair cell loss from underwater sound, the expert panel relied largely on data from other bird species while considering supporting data from terrestrial and marine mammal data (SAIC 2011, p. 16). With corrections to account for the different medium (air versus water), auditory sensitivity, and sound produced (continuous versus impulsive), because of the similar morphological conditions, and expected overlap in auditory range, we conclude that these data provide the most appropriate information to be used as a surrogate for determining the onset of injury due to hair cell loss in marbled murrelets.

Based on the values recommended by the expert panel (SAIC 2011), the USFWS associates auditory damage with the onset of injury, as indicated by hair cell loss in the inner ear, which is expected to occur with exposures of $202dB_{SEL}$. Other physical injuries (i.e., barotrauma) could be expected when SELs meet or exceed $208dB_{SEL}$. Injuries associated with barotrauma include death and/or hemorrhaging and rupture of internal organs.

The proposed project includes several activities that might require pile driving such as pile placement, coffer dam sheet piles, dolphin repairs. The USFWS anticipates both vibratory and impact pile driving associated with PDC #1, PDC #4, PDC #5, PDC #6, PDC #7, and PDC #8. If we assume a worse-case scenario that all proposed available projects for these PDCs include pile driving, as many as 249 projects could include pile driving over the assumed 20 year period of SSNP implementation. However, this vastly overestimates the number of pile driving projects that may occur each year since activities such as culvert replacement or a boat launch may not require pile placement. Therefore, we have assumed that 80 percent of the possible projects would require placement of piles.

Our history of consultations on pile installation reveals that most structures use 12-inch steel piles. Therefore, we assume up to 149 projects will occur each year and on average each of these projects would install 10 12-inch piles per site (up to 1494 piles average per year or 29,880 over the 20-year anticipated duration). While our analysis assumes an average of 10 piles per project, we recognize some projects will be larger and some smaller and the total average number of piles installed per year over the full 20-year period represents the full impact of pile driving effects. The USFWS assumes that a smaller portion of projects (approximately 25 percent) will require large piles greater than 12 inches diameter. We anticipate 62 projects per year will require installation on average of up to two large piles (125 total piles) in any given year. Projects that install more than two large piles per day will follow a Marbled Murrelet Monitoring Plan to reduce the risk of exposure.

To determine the level of underwater sound impact, the USFWS analyzed the total area affected by the above quantities of 12-inch and 36-inch piles that may be placed. As the largest sized pile allowed under SSNP, we chose 36-inch piles for analytical purposes to provide a worse-case analysis on the distance for elevated underwater sound. The use of smaller piles would result in smaller areas of elevated underwater sound. We also assumed the following would be true based on past projects:

> No more than eight piles may be driven per day.
>
> No more than two piles greater than 12 inches may be driven per day without marbled murrelet monitoring.

After using a vibratory hammer, each pile will take up to 500 impact strikes.

The confined or unconfined bubble curtain will result in a 10dB reduction.

To be most protective of the species and allow for the most flexibility of the action, we base our analysis on the assumption that all work occurs in the stratum with the highest marbled murrelet density (Stratum 1) and during the season with the highest marbled murrelet density (winter). The densities are based on the average marbled murrelet densities over the last five survey years.

The USFWS expects that SPLs in excess of $150\text{dB}_{\text{RMS}}$ could result in behavioral responses in marbled murrelets. Impact-hammer installation of hollow 12-inch diameter steel piles can result in instantaneous SPLs of $179\text{dB}_{\text{RMS}}$ and impact-hammer installation of hollow 36-inch diameter steel piles can result in instantaneous SPLs of $175\text{dB}_{\text{RMS}}$, which exceed the level at which marbled murrelets may exhibit behavioral responses. Behaviors that could indicate disturbance of marbled murrelets in the marine environment include increased diving; flushing; increased vigilance; swallowing prey intended for chicks; aborted feeding attempts; multiple delayed feeding attempts within a single day, or across multiple days, multiple interrupted resting attempts, and precluding access to suitable foraging habitat. Reactions to noise disturbance can decrease foraging effectiveness as individuals devote time and energy to response behaviors (Francis and Barber 2013, pp. 309-310). Disturbances that startle animals are perceived as threats and will elicit reactions similar to responses to actual predation risk (Francis and Barber 2013, p. 306). When individuals flee from a perceived threat they stop their typical behavior, expend energy, and are more exposed to predation (Francis and Barber 2013, p. 310). These behavioral responses to disturbance are energetically costly. Kittlitz's murrelets (*Brachyramphus brevirostris*) are an appropriate surrogate species to analyze in regards to marbled murrelets since the two species are closely related, are similar in size, and have similar life histories. The research with Kittlitz's murrelets indicated that increased energy expenditures associated with these behavioral responses result in decreased fitness (reduced reproduction, growth, or survival) (Agness et al. 2013, pp. 13, 19). Responding to disturbance from boats increased the energy demands more in non-breeding birds, which are more likely to fly in response to vessels, than in breeding birds which tend to dive in response to disturbance (Agness et al. 2013, pp. 14, 17). Flight in response to vessels caused non-breeding Kittlitz's murrelets to expend up to fifty percent more energy than they would in the absence of exposure to vessels (Agness et al. 2013, p. 17). Breeding birds, which fly in response to disturbance less often expend up to thirty percent more energy than they would in the absence of disturbance (Agness et al. 2013, pp. 14, 17). Even if breeding marbled murrelets can capture additional prey to offset the energy expense to themselves, the time and energy spent to catch that prey may impact prey deliveries to chicks and threaten nest success (Agness et al. 2013, p. 18). It is probably easier for non-breeding marbled murrelets to compensate for the energy lost to responding to disturbances, but it is unclear if, or how long, they can cope with frequent additional energy needs (Agness et al. 2013, pp. 18-19). A marbled murrelet's ability to compensate for additional energy needs is also dependent on the availability of prey. Forage fish availability is influenced by cyclic ocean conditions and pressures from human population growth (Greene et al. 2015, pp. 163-165). When ocean conditions, fishing, and effects from the human population drive forage fish populations down, it may be especially difficult for marbled murrelets to catch additional prey to compensate for the energy lost to disturbance responses.

Research has shown that non-breeding adult Kittlitz's murrelets need to consume more than a third of their body weight in Pacific sand lance to maintain their typical metabolic rate (Hatch 2011, pp. 75, 81). During chick rearing, adult Kittlitz's murrelets have to consume about two-thirds of their body weight in Pacific sand lance to maintain their typical metabolic rate (Hatch 2011, pp. 75, 81). When energy expenditures are greater than average or when medium- to high-quality prey is unavailable, Kittlitz's murrelets may be unable to consume enough prey to meet their energy needs (Hatch 2011, pp. 87-88). When birds cannot meet their energy needs they become malnourished; they may lose mass (Hatch 2011, pp. 87-88), be less likely to reproduce (Peery et al. 2004, pp. 1094-1095), and/or be more susceptible to infection (Beer 1968, p. 122; Smith 1975, p. 243).

The likelihood that marbled murrelets will exhibit the adverse behavioral reactions to disturbances described above depends on the nature of the disturbance. Continuous, long-duration disturbances are more likely to illicit repeated behavioral responses that could lead to decreased fitness. Observations of seabirds (including marbled murrelets) in Hood Canal found that reactions to pile driving decreased, but did not completely cease, over the duration of exposure. An average of sixty percent of birds showed visible reactions during the first month and then an average of about sixteen percent of birds reacted visibly the following months (Entranco Inc. and Hamer Environmental L.P. 2005, pp. 16-17). Those aggregated observations included more than five different species of birds, but suggest that marbled murrelet reactions to ongoing noise and human activity may decrease over time. However, those observations also suggest that some level of responsiveness persists over time. The mobility of marbled murrelets and area of habitat exposed to potentially-disturbing sound will also affect the likelihood of adverse behavioral reactions. Marbled murrelets are highly mobile and can leave areas with noise from a stationary source. We do not expect a flight over a short distance to leave a noisy area is likely to result in the deleterious outcomes discussed above. By leaving the area marbled murrelets avoid prolonged exposure to potentially-disturbing noise.

These behaviors could result in an increased risk of predation, a reduction in daily feeding or inability to feed such that they have decreased ability to escape from predators or avoid other stressors, or that affects their ability to provide food for nesting chicks. Each pile will take up to 500 impact strikes and 40 strikes occur per minute. It will take 12.5 minutes to install each pile. If 8 piles are installed in a day, there will be a total of 100 minutes of increased noise related to pile driving per day. The proposed action uses vibratory pile driving before proofing piles with an impact hammer, so impact pile driving will be intermittent. The pile installation GCM requires that impact pile driving will not begin earlier than two hours after sunrise and will be complete at least one hour before sunset. During chick rearing, feedings take place at all times of the day and evening but are most common at dawn and dusk (Nelson 1997, p. 18). With the GCM in place to limit the timing of noise disturbance, we do not anticipate behavioral response to noise disturbance to result in missed chick feedings. Due to the short duration and intermittent nature of impact pile driving, and GCMs in place, we expect that underwater sound from the proposed action with the potential to disturb marbled murrelet behavior will be intermittent, short in duration, and limited in area (464 m). We also expect marbled murrelets to leave areas exposed to potentially-disturbing noise and that the short distance travelled by marbled murrelets to leave those areas will not cause an adverse effect to the birds. Therefore, we do not expect underwater sounds from the proposed action to result in marbled murrelet exhibiting behavioral responses resulting in measurable effects to individuals.

Given the assumptions above and based on the annual limit for pile type and size, underwater sound from impact pile driving two 36-inch piles at each of 62 sites would exceed the injury thresholds at 24 feet for SEL barotrauma (208dB), 61 feet for injury (202dB). For projects impact pile driving one or two 36-inch piles in a day, Marbled Murrelet Monitoring is not required. We expect any marbled murrelets that dive into the water within 61 feet of the proposed action while impact pile driving of 36-inch piles is occurring without monitoring to be injured or killed. For larger projects when more than 2 large piles may be driven per day, the Marbled Murrelet Monitoring Plan will be followed. All pile driving will cease if a marbled murrelet enters the area of potential injury. Marbled murrelet monitoring reduces the likelihood of exposure of marbled murrelets to stressors within the monitored area, but is not flawless. More pile strikes increases the cumulative SEL of a project and marbled murrelets as far as 153 feet of active impact pile driving as many as eight 36-inch piles per day will be injured or killed even though marbled murrelet monitoring will be implemented. Marbled murrelet monitoring during pile driving is of up to eight large piles in a day reduces the likelihood of exposure to below the level we would expect to occur from 2 large piles a day and no monitoring. Therefore, for a conservative analysis, when considering the cumulative probability of exposure to injurious sound pressure levels from impact pile driving small or large piles, we assume all impact pile driving of 36-inch piles will be limited to two piles per day and no monitoring will occur.

For the remainder of annual projects (149 projects driving 12-inch steel piles) we base our estimate of the impacts on a "typical" project that would include 10 piles. The USFWS analyzed the distance to the peak SPL and cumulative SEL injury thresholds for driving eight 12-inch steel piles per day, totaling 1494 piles per year. We chose 12-inch piles because they are the largest piles of the most common pile sizes for projects to be covered by SSNP. Given the assumptions above, underwater sound from the driving of eight 12-inch piles would exceed the injury thresholds at 24 feet (202dB) and the barotrauma threshold at 10 feet (208dB). No Marbled Murrelet Monitoring is required for impact pile driving of 12-inch piles. We expect any marbled murrelets that dive into the water within 24 feet of the proposed action while impact pile driving of 12-inch piles is occurring to be injured or killed.

To estimate the number of individuals we anticipate will be harmed by impact pile driving, we consider the cumulative probability of encountering a marbled murrelet during 12-inch or 36-inch impact pile driving. The USFWS expects take to occur when the cumulative probability of a marbled murrelet being exposed to injurious sound is greater than 0.5 ($p > 0.5$). The cumulative probability will exceed 0.5 between every 6 ($p = 0.49$) and 7 ($p = 0.54$) years of the action. Due to the uncertainty in the timing of projects within any given year, we assume 1 individual marbled murrelet will be exposed to injurious sound pressure levels by the end of each 6 year period of the action.

In conclusion, marbled murrelets will be exposed to injurious sound pressure levels from impact pile driving in the action area. We expect any marbled murrelets that dive into the water within 61 feet of the proposed action while impact pile driving of 36-inch piles is occurring to be injured or killed. When more than 2 piles are impact driven per day and marbled murrelet monitoring is implemented, we expect that marbled murrelets as far as 153 feet will be injured or killed. We expect any marbled murrelets that dive into the water within 24 feet of the proposed action while impact pile driving 12-inch piles to be injured or killed. Based on the average marbled murrelet densities, the areas of potential injury, and the proposed numbers of 12-inch and 36-inch piles, we estimate that 1 individual marbled murrelet will be exposed to injurious sound pressure levels from impact pile driving resulting in injury or death once every 6 years of the action. Therefore, for the 20-year period of assumed implementation, we anticipate that no more than 3 individuals will be exposed to sound pressure levels such that the exposure results in injury or death.

Exposure to Elevated In-Air Sound

Marbled murrelets typically forage in marine waters in groups of two or more and are highly vocal on the surface during foraging bouts (Speckman et al. 2003; Sanborn et al. 2005). Individuals of a pair vocalize after surfacing apart from each other and after a disturbance (Strachan et al. 1995, p. 248). When pairs are separated by boats, most will vocalize and attempt to reunite (Strachan et al. 1995, p. 248). Strachan and others (1995, p. 248) believe that foraging plays a major role in pairing and that some sort of cooperative foraging technique may be employed. This is evidenced by the fact that most pairs of marbled murrelets consistently dive together during foraging and that they often swim towards each other before diving (Carter and Sealy 1990, p. 96).

Conspecific vocalizations at sea probably plan an important role in communication between foraging partners, and thus their audibility may play an important role in foraging efficiency (SAIC 2012, p. 13). Assuming vocalization plays a role in a cooperative feeding strategy; interruption of vocal communication could negatively impact foraging efficiency and thereby reduce their health. Similarly, at-sea courtship could be negatively impacted. Based on field observation of foraging marbled murrelets and field research, it is estimated that the social foraging strategy employed by marbled murrelets requires adequate acoustic communication at distances up to 30 meters (SAIC 2012, p. 16). Therefore, foraging pairs of marbled murrelets need to receive these vocalizations at a level they can recognize them at distances up to 30 meters apart from each other during foraging. If significant threshold shifts in their hearing occurs from exposure to in-air sound it could limit their recognition of these communication signals.

We consider effective communication between foraging partners to be the critical hearing demand for marbled murrelets at sea. Signal detection and recognition is significantly affected by the properties of background sound (Brumm 2004, p. 434). Vocalizing animals confront a wide variety of sound sources that are both abiotic (wind, rain, flowing water, waves, etc.) or biotic (interfering sounds produced by other animals). Masking of the signal can occur when there is a match between the frequencies of the sound and the signal. Masking of communication during foraging could occur if in-air sound levels from pile driving interferes with communication between foraging partners.

In order for in-air sound to interfere with marbled murrelet communication the sound must be both loud enough and at similar frequencies to those used by marbled murrelets for communication. If in-air sound is loud enough at the frequencies of marbled murrelet calls the sound can obscure, or "mask," the communication. We do not expect intermittent impact driving of piles 36 inches in diameter or smaller to result in masking. The proposed action uses vibratory pile driving before proofing piles with an impact hammer, so impact pile driving will be intermittent. Since the largest piles included in the proposed action are 36 inches in diameter and they will be impacted intermittently, we do not expect noise from pile driving to measurably mask communication between marbled murrelets. Therefore, effects to individual marbled murrelets associated with short-term exposures to elevated levels in air sound are considered insignificant.

11.3.2 Effects to Marbled Murrelet from Water Quality Impairments

Elevated Turbidity and Suspended Solids

As discussed above in 11.2.4 *Effects to Bull Trout from Water Quality Impairments*, construction of many of the activities covered under this programmatic may include sediment and substrate disturbing activities. The USFWS anticipates most projects will result in some level of increased turbidity and suspended sediment. The effects of the 17 projects per year expected under PDC #14 Sediment Remediation are discussed separately in the *Contaminants* Section (11.3.2.2) below. We assume turbidity will extend up to 150 ft from any site-specific substrate disturbance. For example, a single pile installation could result in elevated turbidity or suspended sediment in an area up to 1.6 acres (area of a circle with a radius of 150 ft = 1.6 acres). As described earlier, to account for short-term turbidity impacts in marine environments we made assumptions about project sizes and the number of projects. Our assumption is that there will be a variety of project sizes that will result in an average sediment or elevated turbidity equivalent of a project with up to 10 piles or an area 16 acres affected.

Dredging will occur to remove sediments in order to maintain vessel access to docks, marinas, boat ramps, port terminals, industrial docks and wharfs, and outfalls. To estimate impact resulting from dredging associated with the proposed action, we consider the recent level of activity based on past individual ESA Section 7 consultations. The average volume dredged under past projects considered was 6,715 cubic yards. The proposed project includes dredging for vessel access at 5 project per year. The USFWS expects no more than 33,575 cubic yards per year for vessel access dredging (PDC #9). The proposed project also includes minor dredging and clearing of materials for up to 9 projects per year. These projects represent small, site specific dredging at culverts and outfalls. We do not expect impacts to marbled murrelets from the small site specific dredging projects related to culverts and outfalls.

Turbidity and suspended sediment created by these activities is expected to be localized and short-term in duration. Marbled murrelets diving within the affected area may exhibit brief behavioral responses such avoidance or forage in different areas. Marbled murrelets are highly mobile and injury is not currently associated with exposure to elevated levels of turbidity. We do not expect the proposed activities to result in a measurable effects to their normal behaviors or result in injury. Therefore, effects to individual marbled murrelets associated with short-term exposures to elevated levels of turbidity are considered insignificant.

Contaminants

Contaminants may originate from stormwater runoff, pile removal and contaminated substrates. Stormwater related contaminants are described in detail in the *Stormwater Pollutants* section under bull trout. Due to the expected extent of stormwater discharge (150 ft), and the fact that marbled murrelets may forage close to the shoreline in areas where it is rocky or steep, we expect some marbled murrelet individuals may be exposed to stormwater discharge. We anticipate stormwater contaminants will be diluted upon mixing in the nearshore environment and any exposure would be short in duration. Effects to marbled murrelets from short-term exposure to low concentrations of stormwater contaminants are expected to be insignificant. Several other contaminants (creosote, PAHs, etc.) to which marbled murrelet may be exposed are associated with the removal of creosote and other piles, excavation of contaminated substrates and dredging are addressed in this section. The extent of exposure is anticipated to be the physical extent of suspended sediment, which is described in detail above in the *Elevated turbidity and Suspended Sediment* section. The removal of contaminated substrates or creosote piling is anticipated to result in short term suspension of contaminants into the water column.

Creosote will be released during the removal of abandoned piers and piles. Exposure of marbled murrelets to contaminants associated with pile removal would be limited to direct and indirect effects in marine and estuarine waters where they could be loafing or foraging. As described above in the bull trout *Contaminants* section, turbidity and resuspended sediments or contaminants are anticipated to extend up to 150 ft from pile removal activities. Smith (2008) measured concentrations of PAHs in surface water and surface sediments resulting from creosote-treated post removal. While the concentration of PAHs in surface waters rapidly diluted after removal, PAH concentrations on surface sediments doubled immediately after pile removals and remained at significantly higher concentrations six months later (Smith 2008). Resident benthic organisms may be exposed to PAHs from the creosote, which is toxic to fish when they are exposed to high enough concentrations through their diet, exposure to contaminated water, and/or direct contact with the sediments. Additionally, PAHs may bioaccumulate in aquatic invertebrates within these benthic communities (Varanasi et al. 1989, p. 94-98; Meador et al. 1995, p. 95-104) and benthic invertebrate prey could provide a source of PAH exposure for forage fish of marbled murrelets.

Given the lack of information pertaining to PAH concentrations or the locations of potential pile removal sites, it is difficult to predict with any accuracy what concentrations will be in surface waters and sediments during pile removal, but it is reasonable to assume PAH concentrations in the water column will be elevated for a period of time, at least 1 hour, within the 150-foot radius of pile removal activities, throughout the entire duration of these activities, as a result of resuspension of contaminated sediments and potentially pooled creosote. It is reasonable to assume that there will be short- and long-term elevated concentrations of PAHs in surface sediments in the vicinity of removed piles. It is also reasonable to assume that there will be a net long-term benefit to water and sediment quality associated with removing creosote piles from the environment, thereby permanently removing those contaminant sources.

Direct exposure to suspended sediments in the water column from pile removal would be temporary. Direct exposure to elevated PAH or contaminant levels in the water column would be limited temporally and spatially to the extents specified above. In addition, marbled murrelets will likely avoid areas of disturbance further limiting direct exposure to contaminants suspended during creosote pile removal or other excavation activities. The USFWS expects that any short-term effects from exposure to creosote from piling removal will be immeasurable and therefore considered insignificant.

Indirect exposure to elevated contaminants via consumption of prey species (forage fish) that ingest contaminants directly from the water column or via consumption of benthic prey species inhabiting contaminated sediments would potentially extend over a longer period of time (months). Direct or indirect exposure to creosote-related contaminants is expected to be limited to a very small area (within 150 ft) of pile removal activities in marine areas. Long-term exposure via the food chain will be limited to this same area. Due to the very limited size of possible impacts to sediments and resultant effects to marbled murrelet prey resources via the food chain we do not expect the marbled murrelet prey base to be affected by pile removal to a measurable extent. We view the removal of piles as a net benefit to the species by removing sources of contaminants from the ecosystem.

With proposed BMPs and monitoring, the amount of creosote released will be minimized and the construction-related temporary water quality impacts will be temporarily confined to a small area (150 ft for pile removal), and will not have permanent measurable effects on prey species and the quantity or quality of food chain resources available to marbled murrelets. In addition, we expect that the permanent removal of creosote-treated piles will result in an overall long-term reduction in the release of PAH's into the environment as well as remediation of contaminated sites proposed in the action.

Dredging for vessel access (<33,575 cubic yards per year) and sediment remediation (<50 acres per year) may result in the remobilization of contaminants. BMPs will be followed to minimize turbidity and remobilization of contaminants. Tidal action will disperse resuspended contaminants which is expected to reduce the likelihood of marbled murrelet exposure to harmful concentrations of resuspended contaminants. Furthermore, marbled murrelets will likely avoid areas of disturbance, limiting direct exposure to contaminants resuspended by dredging. Dredging may cause exposure of forage species of marbled murrelet to contaminants. The exposure will be limited in area and duration. We do not anticipate the extent of exposure to lead to altered forage availability or quality. Furthermore, conservation offsets are required for dredging for vessel access activities. The conservation offsets are expected to ultimately have a long term positive impact on the prey base of marbled murrelets.

With proposed BMPs, the temporary water quality impacts caused by pile removal, dredging for vessel access, and dredging for sediment remediation will be spatially and temporarily confined (150 ft for pile removal). In conjunction with the conservation offsets required for dredging activities, these activities will not have permanent measurable effects on prey species and the quantity or quality of food chain resources available to marbled murrelets. Water quality related effects to marbled murrelets or their prey base are considered insignificant.

11.3.3 Overwater and In-water Structures

The proposed action includes installation or expansion of up to 79 in-water and overwater structures per year. In addition, the proposed action includes repair or replacement of 132 existing overwater structures per year. These structures are assumed to remain in the environment for 40 years (NMFS 2022, p. 47). For all overwater structure construction, maintenance, replacement or repair, the SSNP includes conservation offsets to limit the long-term impact of the structures on the environment. In-water and over water structures impact marbled murrelet and their forage through exposure to long-term increased vessel traffic, associated impacts to forage fish spawning habitat, and by interrupting natural habitat processes.

Increased Vessel Activity

Marbled murrelets spend most of their lives in the marine environment including nearshore areas. They forage by pursuit diving in relatively shallow waters, usually between 20 and 80 meters deep, but have also been observed diving in waters less than 1 meter deep and more than 100 meters deep (Strachan et al. 1995, p. 247). Most foraging occurs about 300 to 2,000 meters from shore (Strachan et al. 1995, p. 247). The new structures (i.e., PRFs, mooring buoys, watercraft lifts, marine rails, and stairs) will be installed within 300 meters of shore. We expect that many of the project areas may provide suitable foraging habitat for marbled murrelets, depending on location, and they could be present at any time.

We expect that marbled murrelets foraging in marine waters adjacent to densely populated areas are more acclimated to the higher levels of vessel traffic associated with these areas. The USFWS estimates based on past and expected project numbers that the total area affected by overwater structures will be 220,000 square feet and approximately 50 percent or 110,000 square feet annually will consist of new overwater structures (Table 7). The increase in overwater structures is expected to result in some level of increased vessel traffic, particularly in areas that have existing high levels of vessel traffic. We anticipate exposure to increased vessel traffic to be higher during periods of increased human recreation within the action area resulting in increased vessel traffic, primarily between the months of June, July, and August.

The summer months (June, July, and August) are critical months for breeding marbled murrelets and their young because adults face intense energetic requirements to complete chick-rearing. From mid-May through mid-September, adult marbled murrelets are incubating and/or provisioning newly hatched and/or fledged young (Carter and Stein 1995, p. 99). During July and August many adults may be flightless because they may be molting and still provisioning fledged young (molting can occur any time between approximately mid-July and mid-February after young have fledged) (Hamer and Nelson 1995, p. 49). Winter is another critical period for marbled murrelets with high energetic requirements as they must sustain and increase their body fat. An increased number of marbled murrelets are found in the Salish Sea during winter, increasing the likelihood of exposure of marbled murrelet to disturbance.

Marbled murrelets' behavioral responses to approaching boats have been documented in numerous studies. Most studies involve small (4 to 9 m [13 to 30 ft]), motorized boats (Bellefleur et al. 2009, p. 532; Entranco Inc. and Hamer Environmental L.P. 2005, p. 7; Hentze 2006, p. 10; Speckman et al. 2003, p. 32; Strong et al. 1995, p. 339), although one study involved cruise ships (Marcella 2014, entire). These responses generally fall into three categories: avoidance diving, flying, and no apparent reaction. Avoidance dives are distinguished from foraging dives by the bird's behavior immediately before the dive. Avoidance dives are preceded by the bird looking in the direction of the boat, paddling away from the boat, or surfacing very near the boat, followed by an immediate dive (Entranco Inc. and Hamer Environmental L.P. 2005, p. 14). When marbled murrelets respond to small boats, avoidance dives are the most common response. Between 8 and 31 percent of marbled murrelets dive when approached by a small boat, whereas between 1 and 15 percent fly, and between 58 and 90 percent had no apparent response (Bellefleur et al. 2009, p. 4; Entranco Inc. and Hamer Environmental L.P. 2005, p. 14; Hentze 2006, p. 3; Strong et al. 1995, p. 347). Notably, in the case with the lowest response rate, marbled murrelets were actively foraging on herring, even though the birds were less than 300 m from active marine pile driving (Entranco Inc. and Hamer Environmental L.P. 2005, pp. 9, 20). A species that feeds on mobile or aggregated prey, like herring, may be especially committed to high-value foraging sites, regardless of the presence of potentially disturbing stimuli (Gill et al. 2001, p. 267). In another case, however, nearly all of the birds that flew in response to the boat also left the area where they had been foraging previously, relocating at least 200 m away (Bellefleur et al. 2009, p. 5). Hentze (2006, p. iii) found that marbled murrelets did not dive when vessels approached at distances of 90 meters or greater and did not fly at approach distances of 100 meters. The likelihood of marbled murrelets reacting at all, or leaving the area in particular, increases in windy conditions, when the sea state is choppy, and decreases when they are in a group (Hentze 2006, p. 20). Marbled murrelet response to large cruise ships is more likely to involve flight, and nearly all individuals respond to approach by cruise ships (Marcella 2014, p. 56).

Kuletz (1996) measured the effects of human disturbance to seabirds on the water, such as that caused by vessel traffic. That study found that the number of marbled murrelets at sea was negatively correlated with the number of boats (1996, p. 776) and evidence also suggested that breeding may have been disrupted (Kuletz 1996, p. 779). Even in areas where marbled murrelets may habituate to existing boat traffic, changes in boat activity may affect their foraging activity. Faster vessels are also associated with a greater proportion of marbled murrelets flushing (flying or diving) and at further distances and those that did flush, tended to fly entirely out of feeding areas (Bellefleur et al. 2007, p. 1). Additionally, juvenile marbled murrelets flushed more frequently than adults, but at closer distances (Bellefleur et al. 2007, p. 1).

Fish-holding marbled murrelets also sometimes swallow the fish when approached by boats. This response has been observed at least eight times, all in cases when the bird was holding fish crosswise in the bill (Speckman et al. 2004, p. 33). The researchers did not report the total number of fish-holding birds they approached, so the rate at which fish-holding marbled murrelets swallow the fish as a startle response remains unknown. Marbled murrelets also hold fish lengthwise in the bill (Carter and Sealy 1987, p. 289), which may make fish-holding and fish-swallowing behavior more difficult to detect.

Increased vessel traffic may result in behavioral responses such as avoidance diving, flushing, leaving the area. These behavioral responses may negatively influence normal breeding and feeding by causing a marbled murrelet to swallow a fish intended for its nestling, expend more energy during foraging, or forego a breeding attempt.

We expect that for adult, subadult, and fledged juveniles, the consequences of behavioral responses to vessel activity are reduced energy intake when foraging is interrupted, and increased energy output from flight, and diving. In many cases, the consequences of the reduced energy intake or increased energy output will be insignificant. Insignificant effects are expected for non-breeding birds when forage conditions are moderate or good, because we expect that they will be able to forage more at a different time to compensate. Similarly, breeding birds in good body condition will sometimes experience insignificant effects, especially when they are not exposed frequently, even if they must occasionally use body reserves to maintain the energetic demands of breeding. Breeding birds that are exposed more frequently, that are not in good body condition, or that are experiencing low food availability are likely to experience reduced breeding success, and we expect that some will forgo or abandon nesting attempts due to increased energy expenditures. In very poor forage conditions, we expect that breeding and non-breeding birds will experience malnutrition, increasing the likelihood of starvation, or mortality or illness due to infections or toxic exposures.

When breeding adult marbled murrelets drop a fish that they were holding to take inland to their offspring, there are two potential outcomes (Speckman et al. 2004, p. 33). If prey suitable for delivery to the nestling are readily available, and it is early enough in the day, the adult may be able to catch another fish to replace the swallowed fish. This outcome will result in additional energy costs to the adult. Although this outcome involves the adult swallowing a fish it was not intending to eat, it is not clear that this unexpected meal for the adult actually results in additional energy intake for the adult, because when food is readily available, breeding adults are likely already operating at maximum capacity for food intake, in which case additional ingestion would lead to a digestive bottleneck (Elliott et al. 2014, pp. 138, 143). If it is not feasible for the adult to obtain a replacement fish, the nestling will miss a meal, with energy costs to the chick. Depending on forage conditions in any given breeding season, as well as how often a particular adult swallows fish intended for a nestling, the effects to the chick may be negligible or severe, but can result in the death of the nestling, if its development is not sufficient for successful fledging.

Marbled murrelets are expected to experience adverse effects associated with vessel traffic. The proposed action includes the repair, replacement, and installation of up to 110,000 square feet of new overwater and in-water structures each year and is expected to lead to some increases in vessel traffic. The amount of vessel traffic associated with the proposed action is not expected to be distinguishable beyond background levels and the majority of these effects are expected in existing high use areas. A small number of marbled murrelets individuals would be approached by boats at distances less than 100 meters and may respond through reduced foraging activity and flushing. Individual exposures will be infrequent and short in duration but will occur intermittently as a stressor from the proposed activities. We do not anticipate individual marbled murrelets will be approached at distances under 100 meters at a frequency that would aggregate to an energy expenditure significant enough to result in injury or harm. We do not expect the behavioral effects experienced by individual marbled murrelets to lead to injury or death and effects from increased vessel traffic are considered insignificant.

Altered Forage Conditions

As described earlier under *11.2.6 Altered Forage Conditions*, installation of 79 new or expanded overwater structure or 132 repair, maintenance or replacement of existing structures may result in long terms impacts to habitat for forage species utilized by marbled murrelets. The USFWS estimates, based on past and expected project numbers, that the total area affected by overwater structure will be 220,000 square feet, and approximately 50 percent (or 110,000 square feet) annually will consist of new overwater structure (Table 7). Repair and replacement of existing overwater structure and shoreline modifications are expected to hinder the restoration or improvement of existing degraded forage resource habitat function in the action area, but we do not expect these projects to worsen existing conditions. However, new or expanded overwater structure and shoreline modifications are expected to have a greater impact on forage resource habitat function. The USFWS anticipates up to 24,000 linear feet of shoreline modification to occur (Table 7). In addition, up to 33,575 cubic yards of dredging will occur each year to provide vessel access. Each of these impacts are expected to alter the quality and availability of submerged aquatic vegetation habitat crucial in providing cover and a food base for forage fish, which are prey resources for marbled murrelet. When submerged aquatic vegetation (SAV) is shaded the primary productivity is reduced, especially if the vegetation does not receive the light it needs to survive.

Piers, ramps and floats and the boats associated with them shade intertidal habitat. New floats are generally grated, but boats and floating boat lifts are not; floating boat lifts can create more shade than the PRF or lift structures do depending on their size. The additional shading from the boat lifts and boats reduces the light transmission to aquatic vegetation that provides refuge for some spawning forage fish (i.e., Pacific herring). There are few studies that specifically examine the effect of overwater structures on submerged aquatic vegetation types other than eelgrass and kelp (Mumford 2007). Fresh et al. (2006) researched the effects of grating in residential floats on eelgrass, one matrix upon which Pacific herring spawn, and reported a statistically significant decline in the density of eelgrass shoots under most floats studied in northern Puget Sound. The physiological mechanism that reduces shoot density and biomass associated with shading applies to all types of submerged aquatic vegetation because of their universal need for adequate light transmission to survive. Reductions in submerged aquatic vegetation are expected to reduce the primary production of the various types epibenthos present (Haas et al. 2002).

Spawning areas for Pacific herring are largely limited to depths where submerged aquatic vegetation can grow; Pacific herring also use several other species of macroalgae for spawning. In shallower areas, *Zostera marina* is of primary importance, and in slightly deeper areas, Gracilaria spp. predominates (Penttila 2007). Other types of submerged aquatic vegetation used for spawning by Pacific herring include “algal turf,” often formed by dozens of species of red, green and brown algae, (Penttila 1973). In deeper water and in areas where native eelgrass beds do not predominate, herring spawn on the mid-bottom-dwelling red alga *Gracilariopsis* sp. (referred to as Gracilaria in some sources) (Penttila 2007). There are few species of marine macro-vegetation that can tolerate the reduction in ambient light within the direct footprint of a typical overwater dock or pier. Additionally, herring eggs deposited on wood pilings associated with overwater structures may be impacted by contaminants and higher risk of thermal shock and desiccation of eggs. New overwater structures can also impact other forage fish spawning habitat (i.e., Pacific sand lance and surf smelt) by introducing propwash scour and reducing input of sediment by changing the drift cell pattern.

Shoreline armoring physically buries the upper intertidal zone and blocks, delays, or eliminates natural beach erosion. The erosion process maintains forage fish spawning substrate on beaches. Eroding shoreline bluffs provide a constant supply of new sand and gravel to surf smelt and sand lance spawning beaches. Eliminating or reducing this process may lead to the coarsening of beach substrate, lowering of beach elevation, and long-term degradation of spawning habitat. Shipman (2010) states that “Shoreline armoring might be the greatest threat to surf smelt and sand lance spawning habitat, as armoring affects beach morphology and results in the direct loss of spawning habitat…”.

The installation of up to 110,000 square feet of new or expanded overwater and in-water structures and up to 24,000 linear feet of shoreline armoring as well as up to 33,575 cubic yards of dredging for vessel access each year will result in long-term significant adverse effects to forage species and their habitat for marbled murrelet. This quantity of impact each year is expected to result in measurable, persistent and long-term effects to forage quality and availability. New and expanded overwater structure, especially in areas of eelgrass beds, and new shoreline armoring will result in the loss of existing functioning habitat and will increase the overall area of degraded conditions within the action area. Over the assumed 20-year period of implementation, the accumulated loss of habitat function may significantly increase declines in forage species diversity and availability, particularly with respect to eelgrass beds and herring productivity, and spawning beaches and sand lance productivity.

Decreased prey availability leads to increased energy expenditure by marbled murrelets. Foraging activity of marbled murrelets has been shown to have a linear relationship with prey availability (Ronconi and Burger 2008, p. 256). Marbled murrelets increase diving activity in years with low prey availability and decrease diving activity at sites with high prey availability (Ronconi and Burger 2008, p. 245). Breeding phase further increases diving activity when prey availability is low. When prey is available, there has been no observed increase in diving activity when an adult marbled murrelet is incubating or rearing compared to non-breeding. However, when prey is scarce, foraging effort increases when an individual is incubating or rearing (Ronconi and Burger 2008, p. 253). The increase in foraging effort exhibited by marbled murrelets when prey availability declines is an increased energy expenditure.

Low prey availability can affect reproduction. For seabirds in general, when forage conditions are moderate to poor, many individuals forgo breeding (Cairns 1987, p. 264; Cury et al. 2011, p. 1704; Field et al. 2010, p. 2228-2231; Furness 2007, p. 249). This phenomenon has been observed for marbled murrelets, as well. Marbled murrelets have decreased reproductive success in years with low prey availability (Becker et al. 2007, p. 276; Peery et al. 2004, p. 1094-1095;

Ronconi and Burger 2008, p. 252). Increased forage activity does not buffer against decreased prey availability and ensure average levels of reproduction (Ronconi and Burger 2008)(Becker et al. 2007, p. 267).

Increased energy expenditure without increased energy intake can also affect survival. In general, long-lived seabirds like marbled murrelets are expected to prioritize their own survival over their breeding success in any given year (Davis et al. 2005, p. 1047; Kitaysky et al. 2007, p. 246). Marbled murrelets in California had better survival rates in a year with poor prey availability than in a year with better forage conditions, probably because fewer attempted breeding in the year when food was scarce (Peery et al. 2006, p. 83-85). However, at least for some seabird species, there is evidence that adults may sometimes continue a nesting attempt, even when increased effort is required, and this can decrease adult survival rates (Davis et al. 2005, p. 1054). It is not clear whether there are conditions in which breeding marbled murrelets would prioritize the success of a current nesting attempt over their future survival, but especially during moderate or poor forage conditions, increased energy demands during the breeding season are likely to require them to prioritize either current reproductive success or survival. When forage conditions are very poor, marbled murrelets are likely to have lower-than-usual survival rates even when they are not attempting to breed, and additional energy expenditures are likely to reduce survival rates further. For seabirds in general, forage conditions poor enough to cause adult starvation are thought to be rare, and typically associated with anomalous ocean conditions (Cairns 1987, p. 262). However, these conditions do occur, and may be increasing in frequency; several mass recent mortality events involving emaciated adult alcids have occurred along the Pacific Coast, from California to Alaska (Jones et al. 2018, p. 3193, 3197; Jones et al. 2019, p. 8-9, 11, 16). Within the action area, mass mortality of adult rhinoceros auklets (*Cerorhinca monocerata*) in 2016 was linked with poor forage fish availability (Hodum et al. 2018, p. 5, 10-12). The diets of rhinoceros auklets and marbled murrelets substantially overlap, and although widespread adult starvation of marbled murrelets has not been observed, three individual adult marbled murrelet carcasses have been found in the action area in emaciated condition (NWHC 2011, p. 1; NWHC 2012, p. 1; NWHC 2015, p. 1).

There are a variety of factors that can affect the physical condition of marbled murrelets, including prey availability, breeding (or attempting to), disease, toxic pollutants, travelling long distances, and disturbances. These stressors can interact. For example, when birds become malnourished, they become more susceptible to infection (Beer 1968, p. 122; Smith 1975, p. 243). Similarly, toxic exposures can interact with malnourishment, with nutritional deficiencies leading to more severe effects from some kinds of toxic exposures (Eeva et al. 2003, p. 1246-1248; Fox 1979, p. 96-100). Therefore, we expect that in situations when marbled murrelets become malnourished due to energy expended on increased forage activity, they will not only be at increased risk of mortality due directly to starvation, but will also be at increased risk of illness or mortality due to infection or exposure to toxic pollutants.

Food abundance and body condition influence baseline and peak corticosterone levels in common murres and other seabirds (Kitaysky et al. 1999, p. 579-581; Kitaysky et al. 2007, p. 249-252). If and when marbled murrelets become malnourished due to increased energy expenditure that is not offset by increased intake, baseline corticosterone levels and peak stress-induced levels may both rise. Increased baseline and stress-induced corticosterone levels may be beneficial for adult survival, as they facilitate foraging behavior and mobilize stored energy reserves for movement, but can lead to reduced effort spent on breeding (Kitaysky et al. 1999, p. 583; Kitaysky et al. 2001, p. 620, 622-624; Kitaysky et al. 2007, p. 251). However, common murres with elevated baseline corticosterone levels may also have reduced survival rates (Kitaysky et al. 2007, p. 252).

Decreases in forage availability can lead to energy deficits for breeding adults, non-breeding adults, subadults, and juveniles throughout the year. These energy deficits affect birds differently depending on age, breeding status, and time of year. If breeding adults are faced with energy deficits that deplete their energy stores and reduce their body condition, they may reduce the amount of effort they spend foraging for the nestling or abandon the nest altogether, prioritizing their own survival at the expense of a season of breeding success. Alternatively, they may continue the breeding attempt, potentially with the cost of decreasing their own survival probability. During the pre-basic molting phase, adult and subadult marbled murrelets typically gain weight, even though molting is energetically costly (Peery 2008, p. 119-120). When faced with reduced food availability, they prioritize rapid molting over weight gain (Peery 2008, p. 120). Recently fledged juveniles do not undergo the pre-basic molt, so they are not affected by this trade-off. However, marbled murrelets fledge at only 58 to 71 percent of their adult weight (Nelson 1997, p. 19), so juveniles must continue growing once they reach the marine environment. Marbled murrelets that fail to gain weight during the fall may become malnourished during the winter, when storms can preclude foraging for several days. Marbled murrelet nutritional status at the end of winter likely influences whether or not the bird initiates a breeding attempt.

Low prey availability can affect the survival of nestlings if it results in reduced feedings or feedings of lower quality. Food restriction can significantly affect developmental stages and how the body allocates energy to the growth of different body resources in times of scarcity. Food scarcity and the consumption of inadequate calories has long term effects on the development of young chicks. Growth only occurs within a certain time window and terminates at a specific age, therefore poor feeding conditions can result in either permanent stunting or a failure to reach maturity (Golet et al. 2000, p. 80; Janssen et al. 2011, p. 865). The patterns of growth and prioritization seen in marbled murrelets during times of food scarcity are consistent with the tenets of the adaptive growth hypothesis, which predicts that individual nestlings preferentially allocate resources to growth of high-priority body components (Janssen et al. 2011, p. 864), such as those for flight and feeding. For example, both wing length, bill length, and wing growth were prioritized because they are crucial for prey capture during the first week of independence in the absence of post-fledging parental care. Wing growth is essential to reach independence because failure to reach the ocean on the first flight is usually fatal (Janssen et al. 2011, p. 866). Grounded fledglings that were not able to complete their first independent flight to sea, were exhausted, and had a very low survival rate due to high predation on the ground (DeSanto and Nelson 1995, p. 46). In addition, nestlings have minimum daily energetic demands to sustain life and development, and mortality from starvation occurs when nestlings do not receive sufficient food (Kitaysky 1999, p. 471).

The consumption of insufficient calories can have both short and long term effects to developing chicks. Although there are some compensatory mechanisms that can be activated in the chick body in response to short term reductions in food availability, chicks are most often unable to demonstrate compensatory whole-body growth following calorie deficits (Schew and Ricklefs 1998, p. 296, Brzek and Konarzewski 2004, p. 3072), even following three days of high food availability. There can be significant differences in post-hatching growth rates as a result of the available food supply (Visser 2002, p. 443). Stunting and changes to the chick developmental sequence began when chicks were given 74 percent of an ad libitum diet (Brzek and Konarzewski 2004, p. 3068), demonstrating that even at three-fourths of their normal caloric intake there were significant effects. At 60 percent of normal intake, chicks showed reductions in body mass, tarsus length, and length of the third primary, and wing growth was reduced by 70 percent after only one day, as compared to a control population (Schew 1995, p. 24). Studies in other animals have found that a 50 percent reduction in dietary intake resulted in permanent growth stunting of progeny (Hsueh et al. 1967, p. 197) and impairment in protein absorption (Lee and Chow 1965, p. 442). Food restriction results in effects throughout the body, including a notable reduction in body mass, intestinal mass, pectoral muscle mass, fat reserves, body temperature, and resting metabolic rate (Brzek and Konarzewski 2001, p. 3069). Chicks that were maintained on a diet that only supported maintenance for 10 days slowed wing growth to about 20 percent, and tarsus growth to 15 percent of the control group, oxygen consumption decreased, and body temperature dropped. Growth of all tissues except the brain ceased, and the rate of maturation decreased (Schew 1995, pp. 25, 138). When faced with a food restriction, birds depend on fat reserves, but their reserves can be depleted rapidly. Structural growth is maintained at the expense of other body tissues such as the intestine, which can be catabolized as a source of protein in the absence of any fat reserves (Schew 1995, p. 24). When growth is slowed but maturation is not similarly delayed, the chick's developmental trajectory deviates from its normal course, and the chick could fail to attain normal adult size before maturity closes off the growth phase. The result would be permanent stunting and reduced fitness (Richner et al. 1989, p. 620). In addition, growth retardation is also linked to impaired immune function, reduced cognitive function, and metabolic disturbances (Branca and Ferrari 2002, p. 14, Criscuolo et al. 2008, p. 1568). As a collective, all of these effects influence the adult morphology of the bird (Searcy et al. 2004, p. 274) and its lifetime fitness.

Individual projects within the proposed action may have small impacts on forage productivity and availability in localized areas. However, no project within SSNP will be of a scale to cause measurable affects to foraging availability across the action area, and we do not anticipate any changes in foraging detectable beyond baseline forage conditions. If all impacts to forage availability from projects permitted under SSNP were allowed to aggregate without offsets, the USFWS would expect effects to pacific herring, sand lance, and surf smelt productivity and availability and an associated reduction in nesting success and fitness of individual marbled murrelets.

The proposed action requires conservation offsets for new, expanded, or repaired over water structures and shoreline armoring to provide no net loss of nearshore habitat function and offset impacts to ecological function. The conservation offsets are expected to maintain nearshore habitat function and maintain or increase forage production. The USFWS expects that the realization of restoration and conservation offset projects will take time to provide equivalent function as those lost due to new or expanded overwater structure or shoreline modifications. While Conservation Offset Option 1 would be implemented concurrent with the permitted activity, Option 2 and 3 restoration projects may take up to 3 years to be completed, and Option 4 restoration projects provided thru the Puget Sound Partnership Nearshore Credits Program[34] may take up to 6 years for implementation. During the first 3 – 6 years of the proposed action we anticipate impacts will occur without all mitigation being fully realized. However, these impacts are expected to be small in scale and localized to individual project areas. We do not expect impacts to forage availability to be measurable. After the first 3 – 6 years of the proposed action, conservation offsets are expected to maintain or increase marbled murrelet forage resources and availability at current levels.

In summary, the installation of 110,000 square feet of new or expanded overwater structure and 24,000 linear feet of shoreline armoring per year may impact localized prey availability for marbled murrelet during the initial years of implementation but is not expected to cause a measurable reduction to forage populations. The implementation of GCMs are expected to reduce impacts and the implementation of conservation offsets, habitat enhancement activities, beach nourishment (including placement of spawning gravels), and other conservation measures implemented in the proposed action will compensate for the impacts from new and expanded over-water structures and shoreline armoring. The utilization of conservation offsets within SSNP will prevent per-project impacts from aggregating into measurable impacts to marbled murrelet prey availability. Furthermore, the conservation offsets and BMPs are ultimately anticipated to improve marbled murrelet prey availability in the action area. With the implementation of conservation offsets and the associated no net loss of nearshore habitat function, we consider effects of the proposed action on forage conditions to be insignificant.

11.3.4 Summary of Effects for Marbled Murrelet

Marbled murrelets are expected to experience adverse effects from the proposed action. Short-term construction impacts, specifically pile driving, are rarely expected to reach levels that would result in injury or death. Over the 20-year duration of our effects analysis, we anticipate that no more than 3 individuals will be exposed to sound pressure levels such that the exposure results in injury or death. Impacts of individual overwater and in-water structures and shoreline armoring projects will cause localized reductions to forage fish production or availability but are not expected to cause measurable impacts to forage populations or availability and effects are considered insignificant. The implementation of conservation offsets will prevent these impacts from aggregating to a measurable scale and will ultimately increase forage availability, preventing negative effects from altered forage conditions on the numbers of marbled murrelets or their reproductive success. The proposed action will lead to some increases in vessel traffic associated with the installation of new or expanded over water structure but are not expected to be distinguishable beyond background levels of vessel traffic and effects are considered insignificant. The implementation of conservation offsets, habitat improvement projects, and required elements of the proposed action that limit impacts are expected provide no net loss of

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[34] This PSP Nearshore Credit program (https://www.psp.wa.gov/pspnc.php) is one alternative available to applicants pursuing Option 4 to address Conservation Offsets.

nearshore habitat function and ultimately improve forage resources. With the implementation of conservation offsets, the impacts of the proposed action will not result in impacts at the population scale.

12 BENEFICIAL EFFECTS

Utilization of the SSNP programmatic consultation requires applicants to offset the adverse effects of permitted activities. Conservation activities from the seven categories described above include fish passage improvement; shoreline armoring removal; wetland, shoreline, and floodplain restoration; pile, derelict structure, and derelict vessel removal; set-back or removal of existing tidegates, berms, dikes, or levees; beach nourishment; and contaminated sediments remediation. We expect all projects covered under SSNP will offset the loss of ecological functions by either directly including activities from these categories as parts of those individual projects, or by purchase of credits or payment of in lieu fee that will in turn fund activities from these categories. Implementation of conservation offsets are required to be of equal or greater habitat value than those affected by an activity within the proposed action. 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 the Puget Sound Nearshore Habitat Conservation Calculator (Calculator or Conservation Calculator) for certain activity types. The Conservation Calculator utilizes habitat models to assess impacts (net ecological loss) and benefits (net ecological gain) to nearshore habitats inclusive of the action area.

Project applicants have four options as described in the proposed action to offset debits and ensure each project causes no net loss of nearshore habitat function. Option 1 involves designing the project to minimize and avoid adverse effects. Option 2 is applicant-responsible habitat improvement projects. Option 3 allows an applicant to provide funding to a local habitat restoration “sponsor” to support a restoration project. Option 4 allows an applicant to purchase conservation credits from a USFWS approved conservation bank, in-lieu fee program, and/or crediting provider. The Options and the restoration activities they include to generate credits are described in detail in the proposed action. All Options require credit generating activities to occur in the same basin as the associated debit generating project. In following Option 1, the applicant will implement techniques that reduce negative impacts to ecological function and minimize the initial loss of habitat function associated with their project. Options 1, 2, and 3 include credit generating activities that fall into one of the seven conservation activity categories described above. Each applicant can combine Options as desired to reach no net loss. The benefits of the conservation activities are described in the paragraph below. As Option 1 involves minimizing project impact, it is not associated with a temporal lag between impact and mitigation. A temporal lag between impact and mitigation of the impact is associated with Options 2, 3, and 4. The temporal lag is limited to 3 years for Options 2 and 3 and 6 years for Option 4. The temporal lag is considered when the Conservation Calculator generates the amount of credits required to offset a project. This ensures that all impacts to nearshore habitat function will be offset by credit generating activities, regardless of the time between impact and associated restoration action.

Restoring estuaries, streambank habitat, or levee removal and set-backs provide benefits of creating 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. Removal of derelict structures, piles and vessels will provide benefits to 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. Removal of such structures is expected to reestablish benthic conditions in previously inaccessible areas, which should allow prey communities to recolonize. In many areas beach nourishment will provide improved nursery grounds and other habitat for forage fish species and some groundfish species. Improved beach and shoreline habitats will also provide shelter from predators and food for young salmon. Nourishment does not remove the physical forces that cause erosion but it does help to improve and restore habitats affected by erosion. The removal of shoreline armoring improves intertidal and nearshore habitat quality. It increases cover resulting from increased riparian vegetation and drift wood accumulation. It also increases forage as a result of increased primary productivity and improved forage fish habitat quality associated with increased sediment transport to the beach and accumulation in the intertidal zone, increased riparian cover, and increased SAV. Removal of contaminated sediment will result in long-term improvements to water quality as contaminated sediment is a source of water contamination, and as soil quality is improved. The abundance, complexity, and quality of benthic prey are expected to improve. The increase in the quality and abundance of benthic prey will increase forage success for all species dependent on the nearshore.

All of the activities are designed to have long-term beneficial effects to species via improvements to the quantity or quality of habitat, particularly for forage species of bull trout and marbled murrelet. Conservation offsets will result in removal of contaminant sources such as creosote pilings, shoreline and riparian vegetation restoration, removal of derelict structures as well as other actions that, once implemented, will provide improvements of habitat function, primary productivity, and habitat availability for forage species. The USFWS expects that achieving full benefit of conservation offset projects will take time to provide equivalent function as those lost due to proposed action elements. However, this time delay is considered in the Conservation Calculator and will be accounted for in any alternative method of habitat assessment. The value of a credit is discounted to reflect the temporal lag and ensure the loss of habitat function is fully offset by conservation credits. Based on outcome from decades of Salish Sea restoration and recovery actions it is reasonable to assume that conservation offsets will improve nearshore habitat functions to the benefit of bull trout and marbled murrelet. In areas where habitat restoration activities have been implemented such as dam removal on the Elwha River and resultant estuary restoration and in Hood Canal, forage fish biomass has improved (Figure 4). Over the next 20-years, the USFWS expects that the implementation of conservation offsets for the proposed action will lead to increased forage fish populations. This programmatic approach is expected to result in a substantial improvement in habitat functions relative to the status quo of project specific, stand-alone consultations that do not include conservation offsets required by SSNP. Short term, localized decreases in prey resource may occur due to the temporal lag between project impacts and offsets. However, we anticipate aggregation of benefits provided by SSNP will result in long term ecosystem benefits that maintain environmental baseline conditions in nearshore areas for marbled murrelet, bull trout, and designated bull trout critical habitat.

13 CUMULATIVE EFFECTS

Cumulative effects include the effects of future state or private activities, not involving federal activities, that are reasonably certain to occur in the action area considered in this Opinion. 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.

The proposed action will impact shoreline habitat in marine waters of Puget Sound, Hood Canal, the Strait of Juan de Fuca, and the San Juan Islands. Within Puget Sound, all State, tribal, local, and private actions are required to obtain a Corps permit for work conducted in, over, or under navigable waters under the authority of Section 10 of the Rivers and Harbors Act and/or for the discharge of dredged or fill material under Section 404 of the CWA. Therefore, such actions that are unrelated to this proposed action will require section 7 consultation with the USFWS and so are not further addressed in these cumulative effects section. Other types of actions include residential and commercial development, road and railroad maintenance and construction, and agricultural development. Non-federal actions in tributary systems to marine waters can affect bull trout and marbled murrelet, including timber harvest, land conversion, transportation and other infrastructure development, and other types of development. While many of these activities require section 7 consultation as a result of permitting or funding mechanisms, many do not and can alter the conditions of marine waters by degrading water quality and quantity, and sedimentation levels.

Development in the Salish Sea and Puget Sound area will continue to alter habitat for bull trout and marbled murrelet into the future. Threats to Puget Sound habitat quality include urbanization that increases the amount of impervious surfaces, pressures on water supplies, and water and air pollution (WDOE 2015). The population in the Puget Sound region is projected to add an average of 55,000 more people a year, increasing from approximately 4 million to 5.8 million people by 2050 (PSRC, 2020). We consider human population growth and climate change to be the main drivers for most of the future negative effects on listed species and their habitat under USFWS jurisdiction in the Puget Sound region.

Human population increase results in higher levels of toxic chemicals entering Puget Sound from surface runoff, groundwater discharges, and municipal and wastewater outfalls. These contaminants include oil, grease, PCBs, and heavy metals. Many areas surrounding Puget Sound are highly urbanized with development spreading to the surrounding areas and converting agriculture and forested lands to impervious surfaces. The increase in impervious surfaces increases storm water runoff, which carries contaminants into the action area (WDOE 2006; WDOE and King County 2011, p. 30). Air pollution increases due to increased urbanization also lead to the increased deposition of contaminants such as polybrominated diphenyl ethers (PBDEs, used as flame retardants) into the marine environment (WDOE and King County 2011, p. 32).

Degraded water quality results in metabolic stress. Metabolic stress can result in avoidance responses which prevent or discourage free movement, reduce locomotor performance, and impair olfactory responsiveness. This in turn may compromise growth, long-term survival, and reproductive potential. Contaminants have been found in marbled murrelet and bull trout prey species within the action area at levels that may affect prey health and reproductive success (USFWS 2009, p. 39-40; Liedtke et al. 2013, p. 5). Several of these contaminants increase in concentration as they move up the food chain (Borgå et al. 2001, pp. 191-196). Such contaminants have been shown to cause developmental abnormalities, wasting, disruption of thyroid function, immunosuppression, and decreased reproductive success in fish-eating birds (reviewed in Luebke et al. 1997, pp. 7-10; Rolland 2000, pp. 615, 620-626).

Oil tanker and barge traffic is increasing within the Salish Sea (Felleman 2016, p. 27; Etkin et al. 2015, p. 271). In particular, the Canadian Trans Mountain pipeline expansion project, now owned by the Canadian government as a federal Crown corporation, is expected to be complete in late 2022 (Trans Mountain 2021). This expansion is expected to lead to approximately one additional oil tanker per day departing Burnaby, British Columbia, and traveling through the action area (Felleman 2016, pp. 37-38; Kinder Morgan 2016; Van Dorp et al. 2014, pp. 38, 52), and tanker and tug traffic related to the expansion are projected to increase vessel traffic through the Georgia, Haro, and Juan de Fuca Straits by approximately 7 to 14 percent over 2012 traffic rates (NEB 2019, p. 363).

Increases in oil transportation within the Salish Sea raise the likelihood of an oil spill affecting the action area. A major oil spill here would likely kill marbled murrelets, as has been documented as a result of previous oil spills in other areas (reviewed by Carter and Kuletz 1995, entire). Oil spills may also cause sublethal injury to marbled murrelets and may affect forage fish populations (Carter and Kuletz 1995, p. 264). Oil spill remediation may also be damaging to forage fish populations (Penttila 2007, p. 19). It is unknown what effect a major oil spill would have on bull trout populations.

Within the action area, non-federal public and private lands are managed primarily for timber production. Two HCPs cover management activities on state trust lands managed by the Washington State Department of Natural Resources, and on private lands where the Forest Practices Act applies, respectively. Therefore, effects of land management under these HCPs are not cumulative effects, as defined above. However, marbled murrelets are not a covered species under the Forest Practices HCP. The USFWS determined that the covered activities of this HCP were likely to adversely affect marbled murrelets, but were not likely to jeopardize their continued existence, based on the protection of known occupied marbled murrelet nesting sites required by the Forest Practices Rules.

In Washington, the tonnage and ton-miles of cargo transported by marine vessels in Washington are expected to increase annually by 0.8 and 0.9 percent, respectively, between 2015 and 2035 (WSDOT 2017, p. 8). Some increase in tonnage may be associated with increasing size of ships however increases in vessel traffic are likely to account for some of the increase as well. In the inland waters, oil traffic is likely to increase, while other types of vessel traffic may increase or decrease, depending on economic conditions (WDOE 2019, pp. 43-49). Some increases in shipping may be associated with a federal nexus (e.g., construction of new terminals or expansion of existing terminals that would require permitting by the USACE), and therefore would not constitute cumulative effects addressed here but would be addressed in the consultation for the permitting. Any increase that relies on existing terminal capacity would not be likely to involve a federal nexus and would result in cumulative effects. Increases in vessel traffic are likely to affect marbled murrelets within the Action area.

Bull trout and marbled murrelets will continue to experience direct and indirect effects to the species and their designated critical habitat from human population growth and its associated urbanization and development through habitat degradation, fragmentation, degraded water quality, and impacts to marine forage fish. These effects, especially in the Puget Sound area (Zone 1 for marbled murrelets), will likely adversely influence reproduction and abundance of marbled murrelets, and the distribution and abundance of bull trout.

14 INTEGRATION AND SYNTHESIS OF EFFECTS

The Integration and Synthesis section is the final step in assessing 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 and cumulative effects to the environmental baseline and, in light of the status of the species and critical habitat, formulate the USFWS's opinion as to whether the action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

14.1 Bull Trout

The proposed action involves the ongoing repair, replacement or installation of overwater and in-water structures, implementation of conservation offsets, and other activities within the nearshore environment of the Salish Sea. These activities will result in annual increases in shoreline armoring, overwater structure, increased vessel traffic, short-term impacts from construction, and altered forage conditions. The proposed action includes requirements for the implementation of general construction measures to limit short-term impacts and measures within the PDCs to reduce the overall long-term impacts of the action on the action area.

In 1999, the USFWS listed all populations of the bull trout in the coterminous U.S. under a single DPS as threatened. In the Bull Trout Recovery Plan, bull trout populations were segregated into six Recovery Units across the range of the species, which encompasses 109 Core Areas, 6 Historic Areas, and one RNA (USFWS 2015a). Bull Trout are found throughout the action area and affected individuals may include individuals from as many as nine of the 20 core areas within the Coastal Recovery Unit. In the action area, adult and sub-adult bull trout are foraging, migrating or overwintering. Spawning and rearing areas occur in headwaters of core area watersheds and are not present within the action area. The action area provides foraging habitat for bull trout to grow larger and more fecund. Threats to bull trout found within the action area arise from upland riparian land management activities, connectivity impairments (migration barriers) and reduced forage availability. Ongoing cumulative effects from population growth and urban development will continue to degrade these conditions in the action area into the future.

Though we have data estimating the size of the bull trout population within the action area, specific numbers of bull trout are difficult to quantify and bull trout use of the entire action area is not fully understood. However, best available information indicates that bull trout numbers are low and broadly distributed throughout the action area, and seasonal timing of construction related actions will occur during times when bull trout numbers are lower. Movements into the marine environment typically occur in April through June and return to tributary rivers in July and August as temperatures in embayments and estuaries begin to rise (Goetz et al 2021 p. 1080; Hayes et al. 2011 p. 400). While most (>75 percent) studied bull trout have left marine waters by August, some occupy marine waters year-round. Generally, bull trout are found foraging in nearshores areas that are 2m to as much as 183m deep (Goetz et al. 2004; Goetz et al. 2021). In addition, bull trout have been documented as far as 400m from shore, but the majority of observations were within 100m of shore (Hayes et al. 2011).

The number of bull trout exposed to any one construction activity of the proposed action is expected to be very small. The largest populations of bull trout within tributaries of the Salish Sea are found in the Chilliwack and Lower Skagit Core Areas. These two Core Areas host more than 1000 individuals each and approximately half of adults and subadults studied entered the marine environment in any given year (Brenkman and Corbett 2005; Goetz et al. 2007). All other Core Areas tied to the action area host fewer than 1000 individuals. Bull trout from Core Areas that do not have a major lake or reservoir typically have higher frequencies of anadromy further limiting the number of bull trout that may enter the Salish Sea in a given year. Most anadromous bull trout are likely near estuaries and other areas of with high quality forage fish resources.

During the months of marine residency (April through July), bull trout are more common and broadly distributed. In the non-residency period (August through March), the number of bull trout drop significantly. In North Puget Sound, we expect as many as 1,750 bull trout individuals from four Core Areas will be distributed between Canada, San Juan Islands and Central Puget Sound during marine residency (Table 5). This total reduces to approximately 350 individuals through the rest of the year (Table 5). In Central and South Puget Sound, approximately 700 bull trout from two Core Areas occur during the marine residency and fewer than 150 the remainder of the year (Table 5). The anticipated number of bull trout individuals in Hood Canal and the Strait of Juan de Fuca are very low. Only bull trout from the Skokomish Core Area are expected in Hood Canal at numbers below 50 at any time of year (Table 5). The number of bull trout individuals from the Dungeness and Elwha Core Areas will range from 300 down to approximately 60 throughout the year (Table 5). However, given restoration actions that have led to improved populations in the Elwha Core Area, these totals are expected to increase into the future.

Given the likely small numbers of bull trout entering the action area, combined with the expansive area of the Salish Sea, distance between core areas, and the timing of most construction activities, the USFWS anticipates less than 5 bull trout from any one population would be exposed to short-term construction effects during individual projects, excepting capture and handling activities. While smaller populations in the Stillaguamish and Puyallup may experience proportionally more impacts (5 fish of a 200 fish population), the numbers are so low and distributed so broadly, that the probability of one bull trout experiencing the effects from construction is very small.

14.1.1 Effects of the Action to Habitat Loss, Degradation, and Forage Resources

Due to the low numbers of bull trout likely to be exposed to any one activity authorized by the Corps, the broad sporadic distribution of bull trout from as many as nine core areas, and construction related effects to individuals will be short duration. The effects of the proposed action on forage resources for bull trout will be both negative and beneficial. The long-term loss or alteration of forage fish habitat from overwater structure and shoreline modifications will affect the diversity and abundance of forage. However, the implementation of conservation offsets and other habitat enhancements will reduce the overall effects over time such that no long-term net loss of forage fish productivity is anticipated from SSNP, though short-term (3 to 6-year) temporary and localized loss of habitat function is anticipated. The action area primarily functions as a foraging area for bull trout. Therefore, in the long-term, the USFWS expects the action area will continue to provide this function into the future. At the scale of the Coastal Recovery Unit, we expect short-term adverse effects of individual projects, specifically for forage resources and complex habitat, combined with expected long-term benefits of conservation offsets on forage resources, will maintain the survival and recovery prospective for bull trout in the Recovery Unit. Therefore, we do not expect the proposed action will appreciably reduce the recovery and survival of the DPS with respect to habitat loss, degradation, or forage resource availability.

14.1.2 Effects of the Action to Numbers

Bull trout are expected to occupy the action area at low numbers, which is expected to limit their exposure to the stressors that will result from the proposed action described above in this section. Bull trout abundance is known to fluctuate seasonally, with relatively fewer bull trout expected to be within the action area during the non-residency period from August to March; exposure will be significantly reduced with respect to projects that occur during that time frame. Bull trout populations from all core areas are estimated to be in excess of 1700 individuals during marine residency, and less than 350 individuals during the non-residency period distributed across the action area. Exposure to sound-related effects from pile driving will be minimal, taking into account low population numbers and required measures such as work window restrictions and sound attenuation devices (see GCM#6). These factors do not preclude the possibility that pile driving will have adverse effects. We anticipate injury or death of bull trout arising from installation and replacement of up to 1,494 piles less than 12 inches in diameter, and up to 125 piles between 12 inches and 36 inches piles on average each year for 20 years. While we cannot precisely determine the number of individual bull trout that may experience injurious sound pressures instances of injury are expected to be rare. At a maximum we anticipate injury or mortality of 14 bull trout per year (277 over 20 years) to occur as a result of the proposed action due to entrainment during dredging, direct handling necessary for work area isolation, and injury and/or mortality of a small number bull trout that may be near the 1,494 piles less than 12 inches in diameter and 125 piles between 12 inches and 36 inches. This assumed loss of 14 individuals annually due to entrainment or direct handling, and the assumed loss of a small number due to effects of sound from pile-driving sound impacts each year is a very small proportion of bull trout in the action area in comparison to the estimated population size within any core area. The loss of individuals is small relative to estimated population sizes within any core area. We anticipate the injury and/or loss of these 14 individuals to be distributed throughout the action area and will not disproportionately remove individual bull trout from a given core area. Thus, the loss individuals injured or killed as a result of the proposed action over the 20-year duration of our effects analysis is not expected to appreciably affect bull trout population numbers within the action area.

14.1.3 Effects of the Action to Distribution and Reproduction

The USFWS expects that measurable short-term adverse impacts such as non-lethal behavior changes (avoidance, lost foraging opportunities) will occur related to elevated turbidity during dredging activities. Injury, including injury that results in mortality, of up to 14 individual bull trout per year will occur related to entrainment during dredging, and direct handling necessary for work area isolation. Bull trout are also expected to be injured or killed by sound pressures from impact pile driving, but likelihood of exposure is low due to low populations numbers anticipated to be near any given pile driving event, and required measures such as work window restrictions and sound attenuation devices (see GCM#6). Given the low numbers exposed to construction related effects (handling, water quality changes, elevated underwater sound), and that most of these effects are unlikely to result in mortality, short-term construction related effects are not expected to result in measurable effects to reproduction or distribution of bull trout.

Long-term changes to forage resources and critical habitat (PCEs #3 and #4) have the greatest impact to bull trout individuals and populations over time and affect all individuals that enter the marine environment. Long-term adverse impacts are expected from the repair, replacement, and installation of overwater and in-water structures (up to 220,00 sq ft annually), shoreline armoring (up to 24,000 linear ft annually) and dredging related to vessel access (up to 33,575 CY annually) (Table 7). These elements will result in degraded habitat complexity, modified forage species habitat, and altered forage diversity and availability throughout the action area. These factors all result in degraded or altered forage conditions for bull trout individuals and will lead to changes in foraging areas and changes to types and diversity of prey resources. However, since individual projects that are approved as a result of the proposed action will be relatively small with respect to the amount of habitat they disturb, and projects are expected to be distributed throughout the action area, individual projects are not expected to result in habitat degradation and modified or altered forage availability beyond the local areas where those projects will occur. Taken as an aggregate, the suite of projects that may be approved under SSNP will have adverse effects on forage fish and the nearshore environment. These effects are not expected to result in mortality of individuals but alter the foraging behaviors of individuals such that greater efforts are needed to find forage. These impacts are anticipated most frequently in areas with existing degraded conditions near urban areas such as south and central Puget Sound, Everett, Port Angeles and Port Townsend. The implementation of habitat restoration actions in the proposed action (PDCs #11, #12, #13, and #14) and conservation offsets will minimize this impact over time and increase foraging opportunities in new areas. Due to the broad distribution of bull trout from as many as nine Core Areas across the action area, combined with the low numbers of individuals affected in any one Core Area, and the opportunistic feeding behavior of bull trout, the effects to habitat and forage from these structures will not change reproduction or distribution of bull trout populations.

14.1.4 Effects of the Action to the Likelihood of Survival and Recovery

Up to 277 bull trout may be affected by entrainment during dredging, and direct handling necessary for work area isolation. Of those 277 individuals affected, we anticipate no more than 14 (5 percent) will experience injury or mortality as a result of those activities per year, and these 14 individuals will be distributed throughout the 9 core areas encompassed by the action area. Bull trout are unlikely to be exposed to any one activity authorized by the Corps, and aside from injury or mortality to the 14 individuals from exposure to entrainment and direct handling, most effects to individuals will be short in duration and related to construction. The small number of individuals that will be injured or killed as a result of sound pressures from pile driving are not anticipated to affect the viability of bull trout populations within any core area. The USFWS does not expect that individual adverse effects of the action will appreciably reduce the survival or recovery of bull trout in any of the 9 core areas within the action area or the DPS itself. Individual projects will have short-term, localized, negative effects to forage conditions which are not expected to measurably effect prey availability for bull trout. The implementation of conservation offsets will prevent individual project impacts from aggregating in a measurable way and will ultimately maintain current forage conditions or improve forage conditions in the future. With the conservation offsets included in the action, the likelihood of survival throughout the action area will be maintained at current levels or increased.

We conclude that the action is not expected to reduce appreciably the likelihood of survival and recovery of bull trout within the nine core areas the action area. Therefore, the action is not expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of bull trout range-wide, because we do not expect appreciable reductions in the likelihood of survival and recovery at the scale of any core area.

14.2 Designated Bull Trout Critical Habitat

The proposed action occurs within bull trout critical habitat. Four PCEs for bull trout critical habitat are present in the action area: PCE#2 migration corridors, PCE #3 forage resources, PCE #4 complex habitat, and PCE#8 water quality and quantity. The USFWS expects short-term construction related adverse effects to water quality (PCE#8) and migration (PCE#2). These effects are not expected to reach levels altering the function of these PCEs into the future.

However, long-term adverse effects to forage resources (PCE#3) and complex habitat (PCE#4) are expected from the proposed action. These effects are expected primarily from the installation, repair, and replacement of overwater, in-water, and shoreline structure that alters the natural habitat forming processes adequate for forage resources. With the implementation of habitat enhancements and conservation offsets, the USFWS expects that the function of critical habitat elements will be maintained in their current degraded or at-risk function. The action area primarily functions as a foraging area for bull trout, and we expect this function to continue into the future. The proposed action will not appreciably diminish the conservation value of critical habitat because all impacted areas are related to foraging, migration and overwintering and not spawning or rearing habitats. This distinction is important because over the duration of the proposed action, bull trout spawning and rearing habitat will be unaffected and continue to provide habitat function for bull trout. Therefore, the proposed action is not likely to result in appreciable reduction in the value of designated bull trout critical habitat.

14.3 Marbled Murrelet

The proposed action involves the ongoing repair, replacement or installation of overwater and in-water structures, implementation of habitat conservation offsets, and other activities within the nearshore environment of the Salish Sea. These activities will result in annual increases in shoreline armoring, overwater structure, short-term impacts from construction, but are not expected to result in long-term altered forage conditions due to the requirement of conservation offsets. The proposed action also includes requirements for the implementation of general construction measures to limit short-term impacts and PDCs to reduce the overall long-term impacts of the action on the action area.

The California, Oregon, and Washington population segment of marbled murrelet was listed as threatened in 1992. Marbled murrelets are found throughout the action area, which encompasses marbled murrelet Conservation Zone 1. Individuals from Zone 2 utilize the Salish Sea for foraging and overwintering and will be present in the action area. The action area includes nearshore and marine areas that provide year-round foraging habitat for marbled murrelets, which is considered essential for their recovery and survival.

The Recovery Plan designated the Conservation Zones to be the functional equivalent of recovery units as defined by USFWS policy. Four of the six Zones are necessary to support recovery and enable long-term survival. Specifically, one of the criteria for recovery specifies that "trends in estimated population size, densities and productivity have been stable or increasing in four of the six zones over a 10-year period" (USFWS 1997, p. 113). Furthermore, the Recovery Plan described viable, well-distributed populations in each of the four northern Zones as being necessary to allow for long-term survival and eventual recovery (USFWS 1997, p. 116).

Conservation Zone 5 was not expected to contribute to survival or recovery, due to the extremely limited amounts of nesting habitat, very small population size, and resulting high risk of extirpation (USFWS 1997, p. 115). Conservation Zone 6 was also not expected to contribute to long-term survival, due to the small population size, habitat conditions, lack of federal land, and isolation from other marbled murrelet populations, all factors that increase the risk of extirpation from stochastic or catastrophic events (USFWS 1997, p. 116). Given its slightly larger size, it was expected to contribute to recovery; however, research conducted after the publication of the Recovery Plan indicates that the Zone 6 population is a demographic sink, bolstered by immigrants from other populations but not producing enough young to contribute demographically to the larger metapopulation (Peery et al. 2006, p. 1523; Peery et al. 2010, p. 702; Vásquez-Carrillo et al. 2013, p. 177). Furthermore, current estimates indicate that one quarter of suitable nest trees were killed in 2020 wildfires, likely further reducing the reproductive capacity of this population. Therefore, we assume for this analysis that Zone 6 will not contribute to recovery.

Rangewide, the listed DPS of marbled murrelets is not currently poised for long-term survival and recovery. Although the rangewide population does not show an increasing or decreasing trend for the 2001-2019 period, this lack of a trend is produced by a combination of consistent declines in Washington, increasing populations in Oregon and Northern California, and small populations at the southern end of the range. Long-term survival and recovery will require population stabilization or increase in Zones 1 and 2, as well as continued increase or stability in Zones 3 and 4. Throughout the listed range, all estimates of productivity indicate that reproductive rates are too low to support sustained population stability. Therefore, the DPS is not likely to recover, and the chances of long-term survival appear low, unless productivity can be increased.

Population sizes in Zones 1 through 4 are currently large enough that, if productivity can be increased, long-term survival and recovery will be possible. It is not clear what management actions may be taken to improve marbled murrelet productivity to the point where populations will stabilize or increase. Under the Northwest Forest Plan, various HCPs, and other conservation efforts, some nesting habitat regrowth is expected to occur in the coming decades, to partially offset past and ongoing nesting habitat loss. However, marbled murrelet populations will likely be unable to take advantage of additional nesting habitat if forage conditions deteriorate further. Given changing climate conditions in the marine environment, further deterioration in forage conditions are expected. Therefore, new conservation strategies are needed to increase marbled murrelet productivity and stabilize their populations, factors that are needed for recovery and long-term survival.

The most recent annual population estimate for the entire Northwest Forest Plan area was 21,230 birds and the rate of change for years 2001 through 2019 indicated a 0.5 percent increase per year (95 percent CI: -0.5 to 1.5 percent) (McIver et al. 2021, p. 16). While the overall trend was positive, the trend was inconclusive because the confidence intervals overlap zero, indicating that the range wide population may be declining, stable, or increasing. Monitoring in Zone 1 has shown a clear decline in population size and density. The most recent annual population estimate was 3,143 marbled murrelets (95 percent confidence interval [CI] of 2,030-4,585) and a density estimate of 0.90 marbled murrelets per km^2 in Conservation Zone 1 in 2020 (McIver et al. 2021, p. 16). The population in Conservation Zone 1 has been generally declining, decreasing at around 5.0 percent per year from 2001 to 2020 (McIver et al. 2021, p. 20).

The population decline has been associated with sustained low recruitment. Within Zone 1, there is a low breeding propensity which is likely in part due to the high energetic costs associated with breeding. Compared to marbled murrelets in other areas of their range, nesting adults in the action area have the longest commuting distances between nest and sea, and between shore and foraging habitat (Lorenz et al. 2016, pp. 9, 12-13). This suggests that marbled murrelet breeding attempts in the action area may be stymied by limited access to nesting habitat that was also close to high-quality foraging habitat.

Baseline habitat conditions for marbled murrelets and their prey species have been degraded primarily by human development that has altered natural processes that maintain those conditions. Relevant habitat modifications are increased impervious surface, complexity reductions in river deltas and shoreline habitat, reduced introduction of sediment from beach armoring, elimination of natural coastal bays, and loss of tidal wetlands (Fresh et al. 2011). Other shoreline changes reduce marine nearshore habitat quality including overwater structures, marinas, roads, railroads, and bridges (Simenstad et al. 2011). All these activities modify habitat in ways that reduce the function they provide for marbled murrelets and their prey base.

Increased temperatures and decreased water flow into marine waters are already exacerbating water quality issues. Climate change is likely to continue to affect several ongoing habitat issues such as sea level rise and seawater acidification. Sea level rise will further increase requests to armor shorelines. Increased shoreline armoring and other development will reduce habitat quality for marbled murrelets and their prey resources. Climate change-related habitat stressors combined with further development in shoreline areas are expected to further degrade habitat conditions. We do not expect that the level of restoration activities currently underway or proposed will entirely offset these effects.

While the range-wide abundance status of marbled murrelets is inconclusive (McIver et al. 2021, p. 16) and the population has been declining in the action area, their habitat and prey resources are poor. The baseline conditions of habitat are considerably degraded, primarily by human development. Cumulative effects will continue to intensify, driven by human-related development and climate change. Development and overwater structures are rarely removed once installed. While marbled murrelets may still be able to use habitat adjacent to these structures, we expect that it will function at an impaired level.

14.3.1 Effects of the Action to Numbers

The USFWS anticipates few marbled murrelets from Zone 1 and Zone 2 would be exposed to short-term construction effects during individual projects. The USFWS expects that measurable short-term adverse impacts to marbled murrelet individuals will occur related to elevated sound from in-water pile driving. Over the 20-year duration of our effects analysis, we anticipate that no more than 3 individuals will be exposed to sound pressure levels such that the exposure results in injury or death. Seeing as birds from Zone 1 and Zone 2 utilize the action area for foraging, the three individuals could be from Zone 1 or Zone 2. Due to the requirement of conservation offsets, the installation of new or expanded overwater and in-water structures (up to 110,00 sq ft annually), shoreline armoring (up to 24,000 linear ft annually) and dredging related to vessel access (up to 33,575 CY annually) are not expected to degrade forage species (i.e., herring), or reduce habitat or forage quality (lower caloric species) within the action area. Therefore, no reductions in numbers are expected from impacts to altered forage. The implementation of habitat enhancement activities described in the proposed action, conservations offset requirements in the PDCs, and the expectation that most activities will occur in existing degraded habitat will help to minimize the overall impact to marbled murrelet over time. The USFWS expects effects from the proposed action to numbers to be limited to 3 individuals over the 20-year duration of our effects analysis.

14.3.2 Effects of the Action to Reproduction

The USFWS expects the action to have some impact on the reproduction of marbled murrelet in Zone 1 and Zone 2. The loss of 3 individuals from Zone 1 or Zone 2 has the potential to affect 3 breeding pairs of marbled murrelets. The loss represents a small reduction in reproduction in Zone 1, Zone 2, or both. We cannot determine what proportion of the loss of 3 individuals will be from Zone 1 or Zone 2, therefore we cannot determine if the small reduction in reproduction we are anticipating will occur only in Zone 1, Zone 2, or in both. Breeding success and reproduction in Zone 1 is limited by availability of prey resources and without the inclusion of conservation offsets, the USFWS would expect the proposed action to lead to a more significant impact to reproduction within Zone 1 than in Zone 2. The conservation offsets are anticipated to result in no net loss of nearshore habitat function and will prevent an aggregation of per-project impacts that would lead to a measurable loss of forage resources. Therefore, we do not expect a reduction in reproduction associated with the proposed action. Over time, once the conservation offsets are established and contributing to nearshore habitat function, we expect forage conditions to improve and ultimately increase the reproductive success of marbled murrelet in the action area.

14.3.3 Effects of the Action on Distribution

The marbled murrelets of the DPS that utilize the action area include those that nest in terrestrial habitats in Conservation Zones 1 and 2. (There are also marbled murrelets that utilize the action area that nest in British Columbia, but any impacts from the action to these marbled murrelets will not affect the survival and recovery of the U.S.-designated DPS). The marbled murrelets from Conservation Zone 2 occur in the action area primarily during the non-breeding season. We do not expect the action to interfere with marbled murrelet movements between wintering habitats in the action area and their breeding habitats elsewhere, because it does to create any barriers to movement. We expect that marbled murrelets will sometimes leave areas with loud construction noise or due to an approaching vessel. However, we expect them to return to these areas at a later time, rather than ceasing to use them altogether. Because there will be no permanent disruption of foraging areas for marbled murrelets in the action area, and no disruption in movements between wintering and breeding habitats, the action will not result in a reduction in the distribution of marbled murrelets at the scale of the action area, Conservation Zones, or rangewide.

14.3.4 Effects of the Action to the Likelihood of Survival and Recovery

Due to the low numbers of marbled murrelets likely exposed to any one activity authorized by the Corps, and that aside from injury or mortality to 3 individuals from exposure to elevated levels of underwater sound most effects to individuals will be short in duration and related to construction, the USFWS does not expect that individual adverse effects of the action will appreciably reduce the survival or recovery of marbled murrelet in Zone 1, Zone 2, or within the population segment. Individual projects will have short-term, localized, negative effects to forage conditions which are not expected to measurably effect prey availability for individual marbled murrelets. The implementation of conservation offsets will prevent individual project impacts from aggregating in a measurable way and will ultimately maintain current forage conditions or improve forage conditions in the future. With the conservation offsets included in the action, the likelihood of survival in Zone 1 and Zone 2 will be maintained at current levels or increased.

Criteria for recovery include the presence of a stable or increasing population, as well as stable or increasing productivity, over a period of at least ten years, in at least four of the six conservation zones (USFWS 1997, p. 113). The best available information currently indicates that the Zone 1 population is declining more rapidly than populations in other Zones, and that productivity is currently too low to sustain population stability or increase. However, based on populations and densities in other Zones, the USFWS expects Zone 1 to be essential to meeting recovery objectives. Therefore, productivity must be increased in Zone 1, without simultaneous increases in mortality, in order to reach recovery objectives. The effects of the action will lead to the injury or death of 3 individuals over the 20-year period of implementation. A relatively small portion of the Zone 1 population may experience near-term (3-6 year) diminished prey resource productivity. However, this potential reduction is small relative to overall Salish Sea nearshore productivity and would occur in relatively small geographic areas impacted by the proposed action. With the benefits from conservation offsets SSNP is expected to improve foraging resources in the future which could improve productivity in the long-term. Therefore, we expect the action will not reduce the likelihood of recovery and may improve the likelihood of recovery.

We conclude that the action is not expected to reduce appreciably the likelihood of survival and recovery of marbled murrelets in Zone 1 or Zone 2. Therefore, the action is not expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of marbled murrelets rangewide, because we do not expect appreciable reductions in the likelihood of survival and recovery at the scale of any Conservation Zone.

15 CONCLUSION

15.1 Bull Trout and Designated Bull Trout Critical Habitat

After reviewing the current status of bull trout, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the USFWS' biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout and it is not likely to destroy or adversely modify designated bull trout critical habitat.

15.2 Marbled Murrelet

After reviewing the current status of marbled murrelet, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the USFWS' biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the marbled murrelet. Critical habitat for this species has been designated. However, the Corps determined that the proposed action does not affect designated critical habitat for the marbled murrelet, and so no destruction or adverse modification of that critical habitat is anticipated.

16 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without 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 defined by the USFWS as an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). *Harass* is defined by the USFWS as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to an applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the Corps 1) fails to assume and implement the terms and conditions or 2) fails to require an applicant to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps or an applicant must report the progress of the action and its impact on the species to the USFWS as specified in this Incidental Take Statement [50 CFR 402.14(i)(3)].

17 AMOUNT OR EXTENT OF TAKE

The USFWS anticipates take of bull trout and marbled murrelet as a result of the proposed action. The incidental take of sub-adult and adult bull trout is expected to be in the form of kill, capture, and harm. The incidental take of juvenile and adult marbled murrelet is expected to be in the form of harm. The amount, extent, and form of take is detailed for each species below.

The USFWS anticipates incidental take of bull trout will be difficult to detect for one or more of the following reasons:

> The bull trout are wide-ranging within suitable habitat in the action area and are difficult to detect.
>
> Changes in bull trout numbers in the action area are likely to be masked by natural, seasonal fluctuations in bull trout numbers.

Finding dead or injured bull trout is unlikely.

Mortality may be delayed.

The relationship between habitat conditions and the distribution and abundance of individual bull trout is imprecise such that a specific number of affected individuals cannot be practically obtained.

The USFWS anticipates that incidental take of marbled murrelet will be difficult to detect for one or more of the following reasons:

Marbled murrelets are broadly distributed throughout the action area in low densities.

The action will introduce stressors to large areas intermittently.

Injuries may not manifest until several days after the exposure to injurious SPLs.

When injury and mortality events occur in the marine nearshore environment, individuals that are killed may sink or be transported farther out to sea, where they are extremely unlikely to be recovered.

However, pursuant to 50 CFR 402.14(i)(1)(i), a surrogate can be used to express the anticipated level of take in an Incidental Take Statement, provided three criteria are met: (1) measuring take impacts to a listed species is not practical; (2) a link is established between the effects of the action on the surrogate and take of the listed species; and (3) a clear standard is set for determining when the level of anticipated take based on the surrogate has been exceeded.

The USFWS's regulations state that significant habitat modification or degradation caused by an action that results in death or injury to a listed species by significantly impairing its essential behavior patterns constitutes take in the form of harm. In cases where this causal link between effects of a federal action to habitat and take of listed species is established, and the biological opinion or incidental take statement explains why it is not practical to express and monitor the level of take in terms of individuals of the listed species, the USFWS's regulations authorize the use of habitat as a surrogate for expressing and monitoring the anticipated level of take, provided a clear standard is established for determining when the level of anticipated take has been exceeded.

The following presents the USFWS analysis and findings with respect to the three regulatory criteria for use of a surrogate in this Incidental Take Statement to express the anticipated level of take likely to be caused by the proposed action.

17.1 Bull trout

A coextensive surrogate based on specific project components is necessary to express the extent of take of the bull trout because, with the exception of capture and handling, it is not practical to monitor take in terms of individual bull trout due to the extremely low likelihood of finding dead or injured individuals in the marine environment, and the large geographic extent of the action area. The coextensive surrogate is the direct source of the stressors causing the taking, and a clear standard for take exceedance can be established under the monitoring requirements (below) using this surrogate. On that basis, the extent of take of the bull trout addressed in this Incidental Take Statement is categorized below by project components and described using a coextensive surrogate.

The USFWS anticipates the following forms and amounts of take of the bull trout as a result of the proposed action on average each year for a duration of 20 years beginning the date this biological opinion is signed:

> Take in the form of kill of 14, and in the form of capture of up to 277 adult and subadult bull trout resulting from salvage operations implemented to minimize the incidental take of individual bull trout from dewatering activities or work area isolation.
>
> Take in the form of harm of all sub-adult and adult bull trout from exposure to installation and replacement of up to 1,494 piles less than 12 inches in diameter, and up to 125 piles between 12 inches and 36 inches.
>
> Take in the form of harm of all sub-adult and adult bull trout from exposure to removal of up to 1,494 creosote piles.
>
> Take in the form of harm of all sub-adult and adult bull trout from exposure to dredging up to 33,575 cubic yards for vessel access and up to 450 cubic yards.
>
> Take in the form of harm of all sub-adult and adult bull trout from exposure to sediment remediation of 14,875 cubic yards or up to 50 acres.

The capture and handling of bull trout for salvage purposes will result in direct take (kill, capture, injury). However, the direct take resulting from salvage operations will minimize the incidental take of individual bull trout from dewatering activities.

17.2 Marbled Murrelet

For the 20-year period of SSNP implementation no more than 3 juvenile or adult marbled murrelet individuals will be exposed to sound pressure levels resulting in injury or death.

A coextensive surrogate based on specific project components is necessary to express the extent of take of the marbled murrelet because it is not practical to monitor take in terms of individual marbled murrelet due to the extremely low likelihood of finding dead or injured individuals in the marine environment, and the large geographic extent of the action area. The coextensive surrogate is the direct source of the stressors causing the taking, and a clear standard for take exceedance can be established under the monitoring requirements (below) using this surrogate. On that basis, the extent of take of the marbled murrelet addressed in this Incidental Take Statement is categorized below by project components and described using a coextensive surrogate.

The following levels of incidental take of marbled murrelet in the form of harm are anticipated with implementation of the proposed action:

> Take in the form of harm of juvenile or adult marbled murrelets, resulting from exposure to elevated underwater SPLs during impact pile driving of up to 1,494 steel piles less than 12 inches in diameter, and on average up to 125 steel piles between 12 inches and 36 inches each year for 20 years beginning the date this biological opinion is signed.

18 EFFECT OF THE TAKE

18.1 Bull Trout

In the accompanying Opinion, the USFWS determined that the above levels of anticipated take are not likely to result in jeopardy to the species or the destruction or adverse modification of its critical habitat.

18.2 Marbled Murrelet

In the accompanying Opinion, the USFWS determined that this level of anticipated take is not likely to result in jeopardy to the species.

19 REASONABLE AND PRUDENT MEASURES

"Reasonable and prudent measures" (RPMs)_are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). The conservation measures negotiated in cooperation with the USFWS and included as part of the proposed action constitute all of the reasonable measures necessary to minimize the impacts of incidental take on bull trout or marbled murrelet. On that basis, no RPMs except for monitoring and reporting requirements are included in this Incidental Take Statement. The USFWS finds the following reasonable and prudent measure(s) are necessary and appropriate to minimize the impacts (i.e., the amount or extent) of incidental take of the bull trout and the marbled murrelet (see Table 9 for detailed accountings of the amount and extent of take associated with each RPM below.):

> RPM 1: Monitor the direct take of bull trout from handling and isolation arising from salvage operations.
>
> RPM 2: Monitor the amount and extent of incidental take of bull trout resulting from exposure to impact pile driving and proofing and resulting elevated underwater SPLs.
>
> RPM 3: Monitor the amount and extent of incidental take of bull trout resulting from exposure of bull trout to contaminants released from creosote pile removal.
>
> RPM 4: Monitor the amount and extent of incidental take of bull trout resulting from exposure of bull trout to turbidity released by dredging for vessels and dredging for function.

RPM 5: Monitor the amount and extent of incidental take of bull trout resulting from exposure of bull trout to turbidity generated by sediment remediation.

RPM 6: Monitor the amount and extent of incidental take of bull trout and marbled murrelet resulting from exposure to reduced forage availability from shoreline armoring.

20 TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the Corps and their applicants must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The following terms and conditions are required for the implementation of RPMs 1, 2, 3, 4, 5, and 6:

Term and Condition 1: Annually, the Corps will report the number of projects authorized for each form of take enumerated in Table 9 below, the total extent of the take per year, and a cumulative total of the extent of the take to date. The report shall be submitted to the Washington Fish and Wildlife Office by email at SSNP_WA@fws.gov, attn: Assistant Field Supervisor, by March 15 each year.

Term and Condition 2: The Corps shall ensure that all monitoring reports required as part of a PDC or GCM (fish handling and isolation, sediment dredging; marbled murrelet monitoring, etc.) are submitted by the Corps to SSNP_WA@fws.gov within 90 days of project completion.

Table 9. Metrics for annual reporting on amount and extent of take.

Effects Source	Number of Projects Expected	Number of projects Authorized	Anticipated Take Surrogate	Extent or Total for Year	Total over 20 Year Duration	Total to Date
12" Piles	149		1,494 piles	# of Piles Installed	29,880 piles	# of Piles Installed
36" Piles	62		125 piles	# of Piles Installed	2,490 piles	# of Piles Installed
Dredging For Vessels	5		33,575 CY	Cubic Yards Dredged	671,500 CY	Cubic Yards Dredged
Dredging for Function	9		450 CY	Cubic Yards Dredged	9,000 CY	Cubic Yards Dredged
Handling/Isolation (Salvage Operations)	277		277 and 5% mortality	Individuals Handled and Mortality	5,540 and 5% mortality	Individuals Handled and Mortality

Effects Source	Number of Projects Expected	Number of projects Authorized	Anticipated Take Surrogate	Extent or Total for Year	Total over 20 Year Duration	Total to Date
Creosote Pile Contaminant Removal			1,494 piles	# of Piles Removed	29,880 piles	# of Piles Removed
Sediment Remediation (Dredging)	17		14,875 CY or <50 acres	CY or Acres Remediated	297,500 CY or 1,000 acres	CY or Acres Remediated
New/Expanded Overwater Structure	93		110,000 Sq Ft	Sq Ft	2,200,000 Sq Ft	Sq Ft
Shoreline armoring	63		24,000 linear ft	Linear FT	480,000 Linear Ft	Linear FT

The USFWS is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the Service's Washington Fish and Wildlife Office at (360) 753-9440.

21 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

We recommend the Corps fund a research project that analyzes the long-term impacts of installing permanent features in the nearshore, which should include an assessment of the benefits of grating and other site-specific alterations to habitat and prey resources over the long term. The study should compare the impacts from a representative sample of locations, considering an adequate sample size to provide statistically significant results. Research, data analysis, and reporting should be performed by a third-party organization comprised of qualified biologists.

In order for the USFWS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

22 REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request for formal consultation. As provided in 50 CFR 402.16, reinitiation of formal consultation is required and shall be requested by the federal agency or by the USFWS, where discretionary federal involvement or control over the action has been retained or is authorized by law and: (a) if the amount or extent of taking specified in the incidental take statement is exceeded; (b) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) 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 (d) if a new species is listed or critical habitat designated that may be affected by the identified action.

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