United States Department of the Interior

FISH AND WILDLIFE SERVICE

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

JUL 19 2017

In Reply Refer To:
01EWFW00-2013-F-0360-R001
X-Ref: 01EWFW00-2013-F-0360

Mark Assam
Federal Transit Administration
Region 10
Jackson Federal Building
915 Second Avenue, Suite 3142
Seattle, Washington 98174

Lindsey Handel
Federal Highway Administration
Suite 501, Evergreen Plaza
711 South Capitol Way
Olympia, Washington 98501

Dear Mr. Assam and Ms. Handel:

This letter transmits the U.S. Fish and Wildlife Service's Biological Opinion on the proposed Washington State Ferries Mukilteo Multimodal Project located in Snohomish County and Possession Sound, and its effects on marbled murrelet (*Brachyramphus marmoratus*), bull trout (*Salvelinus confluentus*), and designated bull trout critical habitat. Formal consultation on the proposed action was conducted in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). Your January 12, 2017, request for formal consultation was received on January 23, 2017.

The enclosed Biological Opinion is based on information provided in the January 1, 2017, reference biological assessment form (RBA), and additional information received on March 28, May 30, June 12, and June 15, 2017. A complete record of this consultation is on file at the Washington Fish and Wildlife Office in Lacey, Washington.

If you have any questions regarding the enclosed Biological Opinion or our shared responsibilities under the Act, please contact Julie Hampden at 206-755-8397, or Martha Jensen at 360-753-9000.

Sincerely,

Eric V. Rickerson, State Supervisor
Washington Fish and Wildlife Office

Enclosure

Endangered Species Act – Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
01EWFW00-2013-F-0360-R001

Mukilteo Multimodal Project

Snohomish County, Washington

Federal Action Agency:

Federal Transit Administration
Seattle, Washington

Consultation Conducted By:

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

Eric . Ricker n, State Supervisor
Washington Fish and Wildlife Office

19 JULY 2017
Date

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ACRONYMS AND ABBREVIATIONS

µPa	micropascal
Act	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
BMP	best management practices
BNSF	Burlington Northern Santa Fe Railroad
CFR	Code of Federal Regulations
cy	cubic yards
dB	Decibel
DCu	dissolved copper
DZn	dissolved zinc
FHWA	Federal Highway Administration
FR	Federal Register
ft^2	square feet
FTA	Federal Transit Administration
Hz	hertz
km^2	square kilometers
MHHW	mean higher high-water
MLLW	mean lower low-water
NWFP	Northwest Forest Plan
Opinion	Biological Opinion
PAH	polycyclic aromatic hydrocarbon
PBF	physical and biological feature
PCE	primary constituent element
PGIS	pollution-generating impervious surface
PSU	primary sampling unit
RBA	Reference biological assessment form
RMS	root mean square
RPM	Reasonable and Prudent Measures
SEL	sound exposure level
Service	U.S. Fish and Wildlife Service
SPL	sound pressure levels
SR	State Route
TCu	total copper
TSS	total suspended solids
TZn	total zinc
WDFW	Washington Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries

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INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (Service) Biological Opinion based on the proposed Washington State Ferries (WSF) Mukilteo Multimodal Project located in Snohomish County and Possession Sound, Washington, and its effects on the marbled murrelet (*Brachyramphus marmoratus*), bull trout (*Salvelinus confluentus*), and designated bull trout critical habitat. This formal reinitiation was completed in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). Your January 12, 2017, request for reinitiation of formal consultation was received on January 23, 2017.

This Opinion is based on information provided in the January 2017 Mukilteo Multimodal Project Reference Biological Assessment Project Form (RBA); the April 2012 Biological Assessment Reference for Washington State Ferries Capital, Repair, and Maintenance Projects; the July 8, 2013 Biological Opinion for this project, and the references therein; additional information received March 28 and May 30, 2017; and other sources of information. A complete record of this consultation is on file at the Washington Fish and Wildlife Office in Lacey, Washington.

CONSULTATION HISTORY

The Service completed formal consultation for the Mukilteo Multimodal Project on July 8, 2013 (USFWS Reference Number 01EWFW00-2013-F-0360). Information concerning the status of bull trout and bull trout critical habitat, and the environmental baseline were analyzed in the 2013 Biological Opinion. The information in these sections has not changed substantially since 2013 and is still adequately described in that biological opinion, except where more information is provided below.

The formal consultation for this project was reinitiated due to changes in the project description resulting in a need for formal consultation on effects to the marbled murrelet and a reassessment of the effects to bull trout and bull trout critical habitat.

The following is a summary of important events associated with this consultation since the time of the 2013 Biological Opinion:

- The Biological Assessment was received on January 23, 2017.
- Additional information necessary to initiate consultation was requested from FTA/WSF on February 17, 2017.
- We received a response from our initial information request on March 28, 2017.
- Additional information necessary to initiate consultation was requested on May 19, 2017.
- Additional information necessary to initiate consultation was received on May 30, 2017.
- Clarifying information necessary to initiate consultation was received on June 12, 2017.
- Clarifying information necessary to initiate consultation was received on June 15, 2017.
- Formal consultation was initiated on June 23, 2017.

BIOLOGICAL OPINION

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).

In the RBA dated January 2017, WSF proposed changes to the project description from the 2013 Opinion including changes in the type and quantity of piles, the ground stabilization beneath the terminal structure, the floating dolphin anchor system, the slope protection, and stormwater design. These changes to the project description are summarized below. Unless indicated here, the project remains unchanged from the description in the 2013 Opinion.

Project Schedule

The project has been divided into two phases: Phase I, which was completed in 2016, included removal of the tank farm pier and dredging the navigation channel; Phase II, which includes construction of the new terminal and associated in-water and upland elements, will begin in 2017, and will finish in 2019 when the terminal becomes operational. The shift to the new terminal could occur overnight or with a short closure at night or on a weekend. The existing terminal will be removed after the new facility is in operation, during the 2019 to 2020 in-water work window, likely from December 2019 through February 15, 2020. Demolition of portions of the existing terminal in the upland may continue until July 2020.

All in-water work for the new terminal will be conducted during the August 1, 2017, through February 15, 2018. It will be up to the contractor to define the actual construction schedule; however, WSF's conceptual construction schedule has pile work starting in mid-September. Approximately 6 trestle piles and 100 H-piles will be installed in September 2017. The remainder of the H-piles will be installed around early October 2017, and around 20 trestle piles will be installed below the mean higher high water (MHHW) mark in October as well. All other piles and drilled shafts will be installed from October 2017 through February 15, 2018. If the construction schedule determined by the contractor substantially changes the number of piles installed via impact pile driving in summer (April through September) versus in winter (October through March), WSF will contact the Service to determine whether it is necessary to reinitiate consultation.

Pile Types and Ground Stabilization

Since the time of the 2013 Opinion, WSF has changed the project design in response to the findings of additional geotechnical analysis, including the presence of liquefiable soils within the site, close proximity to the Whidbey Island fault zone, and potentially unstable underwater slopes. The design has changed from using a combination of concrete and steel piles, as outlined in the 2013 project description (111 permanent piles/shafts), to using only steel piles in the current design (240 permanent piles/shafts and 71 temporary piles, including all piles described below except the sheet piles for the coffer dam). Refer to Table 1 for the number of steel piles for each project structure in the revised project description.

In addition, the proposed ground stabilization design using 200 stone columns of 3-foot diameter was eliminated and replaced with a design using steel H-piles to mitigate seismic concerns. The revised design includes vibratory installation of 135 steel H-piles in a grid pattern over a 4,500-square-foot area below the terminal. The top of the piles will be placed below the mudline, and each H-pile will occupy less than 1 square foot of substrate.

The original RBA assumed that all the structures at the existing facility were supported by or made of creosote-treated timber. However, the right inner dolphin at the existing facility is composed of seven 30-inch-diameter steel piles rather than timber piles. Removing steel piles with a vibratory hammer will generate more noise than removing timber piles with a vibratory hammer.

The number of days needed for pile driving during construction of the new terminal facility will depend on the difficulty in penetrating the substrate during pile installation, which may be longer than was estimated in the 2013 Opinion. Only one vibratory or impact hammer will be in operation at a time. The maximum anticipated number of days for in-water pile driving is 138, and the maximum anticipated number of days for pile removal is 39. The estimated durations of pile driving used in this assessment are conservative estimates, and are included for each project element in the *Effects of the Action* section.

<u>Floating Dolphin Anchor System</u>

The original project description indicated that the six existing anchors and chains would be relocated with the existing floating dolphin anchor system. The revised 2017 design includes removing the existing anchors and chains and installing six new anchors (four pile anchors and two stockless anchors). Pile anchors will include H-piles installed with a vibratory hammer on the bottom of Possession Sound to be either flush with or below the mudline. The stockless anchors will consist of one, two, or three anchors in a series, with two anchors being the most likely scenario. New anchor chains will be secured to the anchors and to the floating dolphins, and the majority of the chain will lie in the mud during periods when vessels are not in contact with the structure. A total of four H-piles will be installed as part of the floating dolphin anchor system, as shown in Table 1.

Table 1. Summary of project design updates for the 2017 Revised Design of the Mukilteo Multimodal Project Phase II, compared to the project design covered in the 2013 Opinion

Structure	2013 Biological Opinion	2017 Revised Design
Test Pile Project	N/A	2 temporary steel piles (30 inch diameter)
Trestle and Terminal Building	22 concrete piles (24 inch diameter)	25 steel piles (30 inch diameter)
Overhead Loading	1 drilled shaft (96 inch diameter) and 1 drilled steel shaft (131 inch diameter)	3 steel piles (30 inch diameter) 1 drilled steel shaft (120 inch diameter) 68 temporary steel piles (24 inch diameter)
Vehicle Transfer Span	2 drilled steel shafts (60 inch diameter)	2 drilled steel shafts (78 inch diameter)
Dolphins	4 steel piles (30 inch diameter) and 14 steel piles (36 inch diameter)	10 steel piles (30 inch diameter) 6 steel piles (36 inch diameter)

Structure	2013 Biological Opinion	2017 Revised Design
Wingwalls	18 steel piles (18 inch diameter)	20 steel piles (24 inch diameter) 6 steel piles (36 inch diameter)
Public Fishing Pier	12 concrete piles (24 inch diameter) 37 steel piles (12 inch diameter)	28 steel piles (24 inch diameter) 80-ft by 5-ft gangway and 8-ft by 15-ft float
Public Fishing Pier – Support for Moored Barge	N/A	1 temporary steel pile (24 inch diameter)
Ground Stabilization	200 stone columns (3 ft) 3,142 cubic yards (cy) fill	135 steel H-piles
Floating Dolphin	6 anchors and chains relocated from existing terminal to new terminal	6 new anchors and chains installed (4 pile anchors and 2 stockless anchors); remove anchors from existing terminal
Stormwater Outfall Coffer Dam (temporary, if needed)	N/A	135 steel sheet piles (90 below MHHW and 45 above MHHW)
Upland Promenade Retaining Walls and Slope Stabilization	N/A	112 steel H-piles; 26 of the piles will be located approximately 2 to 3 ft from MHHW. The remaining 86 piles will be approximately 12 to 13 ft from MHHW.
In-Water Slope Protection	6,300 cy of riprap replaced	1,700 sf between -24 ft to -35 ft mean lower low water (MLLW); 375 cy of material; 100 cy of fish mix; 540 cy of riprap replaced
Total	34 concrete piles 73 steel piles 4 drilled steel shafts 200 stone columns 6 anchor chains 0 sheet piles 0 upland piles 9,442 cy fill	0 concrete piles 304 steel piles 3 drilled steel shafts 0 stone columns 6 anchor chains (4 piles) 90 sheet piles 157 upland piles (sheet and H-piles) 1,015 cy fill/riprap

Test Pile Project

A temporary test pile project may be implemented before major construction begins in order to determine the load-bearing capacity of the piles. Two 30-inch-diameter hollow steel piles will be driven with a vibratory hammer, followed by an impact hammer. These piles will be located in the upland near the shoreline, in line with the proposed permanent upland trestle foundation piles. The temporary test piles will be removed with a vibratory hammer or by cutting the piles below the soil line. During the test pile project, acoustic, marine mammal, and marbled murrelet monitoring will be implemented to gather in-water noise data and to protect species of concern.

Upland Slope Protection and Promenade

The 2017 project design includes several mechanically stabilized earth retaining walls, which will be associated with the upland promenade. A total of 112 H-piles will be installed as part of the retaining walls, including 26 H-piles located approximately 2 to 3 feet from MHHW. The remaining 86 piles will be installed approximately 12 to 13 feet from MHHW. No in-water work will occur during installation of piles for the promenade; however, a subset of the H-piles closest to MHHW (3 piles) will be included in the hydroacoustic monitoring plan to determine if underwater sound is exceeding levels of concern in the water. If it is determined during hydroacoustic monitoring that sound pressure levels associated with impact driving of piles in the uplands/dry are exceeding threshold levels in the water, reinitiation of consultation will be required. Pile driving for the upland slope protection and promenade will likely occur between July 2018 and April 2019.

Public Fishing Pier

The design for the public fishing pier was updated to include an 80-foot by 5-foot gangway and an 8-foot by 15-foot float, which will increase the amount of overwater cover created by the project by 520 ft^2. The design for the public fishing pier in the 2013 Opinion consisted of 3,455 ft^2 of overwater cover and the new design will result in 3,975 ft^2 of overwater cover.

Construction Barge

In addition to the barges described in the 2013 Opinion, a barge may be used for transporting materials for the construction of the upland portions of the terminal, which will require approximately 58,000 tons of gravel. The size of the barge needed to transport the gravel is estimated to be 75 feet by 250 feet, or 55 feet by 180 feet. The barge is proposed to moor and offload material along four steel piles on the edge of the fishing pier. To provide additional support for the moored barge, one temporary steel pile will be installed with a vibratory hammer as a breasting pile just west of the fishing pier. The fill material for the upland portion of the terminal will be offloaded using an enclosed conveyor system temporarily located on the fishing pier piles.

All barges associated with the project are expected to be present in the action area for up to 7 months between 2017 and 2020, and will be moved depending on work activities. The applicant will communicate barge schedules and movements during construction and demolition to tribal partners 7 days in advance.

In-Water Slope Protection

The 2017 project design includes the placement of riprap slope protection along the toe of the slope in order to prevent scour from propeller wash from destabilizing the slope. In-water slope protection was not included in the 2013 Opinion. A dive survey was completed in April 2015 to determine the approximate extent of the existing riprap. The survey found that existing riprap slope protection extends only partway down the slope at the project site. Under certain conditions, such as low water and high winds when the ferry captains may need to use high throttle, ferry vessel propeller wash scours the bottom of the slope below the riprap, which could destabilize the slope and cause the existing slope protection to be damaged or fail.

To address this issue, riprap will be added to the toe of the slope to prevent scour and slope destabilization. The slope protection design includes 375 cubic yards of new riprap placed over an area of approximately 1,700 square feet between elevations -24 feet to -35 feet MLLW. The riprap will be placed on the existing mud line and will not require any additional earthwork or dredging. Approximately 540 cubic yards of existing riprap between the +5 and -21 feet MLLW level will be removed and replaced with the new riprap. The riprap will be removed and placed from barges using clamshell equipment. WSF is evaluating whether placement of fish mix over the rock substrate would be stable. If the analysis determines that fish mix will stay in place, approximately 100 cubic yards will be placed over the new riprap in order to create benthic habitat. The slope protection work is expected to occur over approximately 3 to 4 weeks.

According to the additional information provided in a March 28, 2017, response from WSF, modeling of potential scour issues on the slope did not include modeling the effectiveness of riprap slope protection in ensuring slope stability. If slope failure occurs, and the WSF determines that additional armoring is needed, reinitiation of consultation will be required.

Stormwater Treatment

The 2013 RBA incorrectly stated that existing pollution-generating impervious surface (PGIS) totaled 2.43 acres, and proposed adding 10.2 acres of new PGIS. The actual quantity of existing PGIS was updated to 8.1 acres in the 2017 RBA. The 2017 project design will create an additional 0.8 acre of PGIS, mostly by converting the impervious surface of the Tank Farm property to roadway and holding areas, for a total of 8.9 acres.

The 2013 project description included three outfalls that would be used for project stormwater runoff: the existing Brewery Creek outfall, an existing 30-inch-diameter storm drain (running north-south through the middle of the site), and a new outfall that would be located east of the terminal building. The 2017 design proposes to use only two outfalls for project stormwater runoff: an existing 24-inch-diameter storm drain outfall located within Park Avenue and a new outfall that will be installed in the same location east of the terminal building (Figure 1). The existing 30-inch storm drain will remain in place, but runoff from the project will not drain to it.

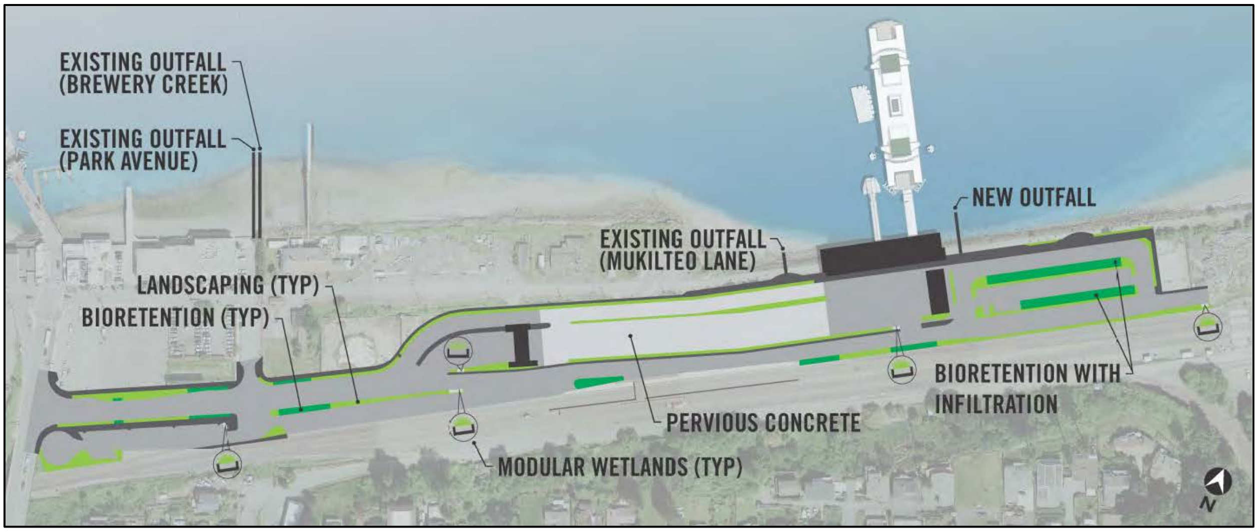

Figure 1. Locations of existing and proposed stormwater features for the Mukilteo Multimodal Project Phase II.

Enhanced treatment will be provided for all stormwater generated on site and will be accomplished by three different means: 12 bioretention facilities, 6 modular wetland systems, and 1.6 acres of pervious concrete pavement with a large sand filter. Of the 8.9 total acres of PGIS, 7.8 acres will discharge to outfalls and 1.1 acre will be treated by infiltration. Areas that infiltrate will also receive enhanced treatment prior to infiltration. The roof of the new terminal building will not receive stormwater treatment because it is not considered PGIS. Consistent with the 2013 project description, the Mukilteo Terminal and holding areas will be cleaned quarterly with a vacuum sweeper, which will reduce pollutants in the stormwater and receiving water body.

Infiltration into native soils is not proposed in the area of the holding lanes due to the presence of subsurface contaminants and culturally sensitive material. To achieve the required grade, 4 to 6 ft of material will be imported in this area. Where pervious pavement is proposed over the areas of concern, and where no existing asphalt is present, a liner (geosynthetic, asphalt, or clay) will be installed to prevent the infiltration of stormwater.

Installation of the new outfall will likely require vibratory installation of a sheet pile coffer dam to isolate the work area while the outfall is being constructed. Directional drilling is another alternative, which would eliminate the need for a coffer dam and the open trench scenario for the outfall pipe installation.

If a coffer dam is required, construction will include work on the beach between MHHW and -4-foot MLLW, and removal of a portion of riprap along the shoreline to access the area. Approximately 135 sheet piles will be installed with a vibratory hammer from 90 ft below to 45 ft above MHHW. Once the sheet piles are installed, the area behind the walls will be dewatered. Because installation of the sheet pile is a relatively slow process that will result in vibration in the water and in-water work, it is extremely unlikely that fish will remain in the area and become trapped within the coffer dam. However, a biologist will seine the area prior to

dewatering to ensure that there are no fish trapped inside the coffer dam. If fish are encountered, they will be transferred to aerated buckets, identified, counted, and released at least 100 feet from the coffer dam. Water from the dewatering process will be pumped to a temporary upland location where it will be pumped or infiltrated into the soils in a location separate from the project's permanent infiltration facilities.

A backhoe will be used to excavate approximately 161 cubic yards of sediment below MHHW to a depth of approximately -5 ft MLLW. Excavated material will be stockpiled on the project site and contained to prevent turbid water from draining off the site. Once excavated, a 30-inch concrete or polyvinyl chloride outfall pipe will be set in place. Sediments will be backfilled around the excavated area and regraded. Approximately 160 cubic yards of riprap will be placed around the mouth of the outfall pipe, and armor rock along the shoreline will be replaced. The sheet piles will then be removed. The work will take approximately 4 weeks, and would occur between November 2018 and February 15, 2019, during the approved in-water work window.

Conservation Measures

The WSF's standard Construction Minimization Measures, are described in detail in the RBA Reference Section 2.3 (p. 73) and are incorporated here by reference. Additional best management practices (BMP) that will be incorporated into the project are highlighted on page 19 of the RBA and are hereby incorporated by reference.

The project has been designed to avoid impacts to areas known to be contaminated, where possible. The terminal building, bulkhead, trestle, and bridge seat (project components with the deepest foundations), and outfall location will all be constructed outside of areas with known surface or below ground soil contamination. Project features requiring excavation may encounter confirmed or suspected contaminants of concern in groundwater and/or soil during construction. Additional testing will occur in those areas prior to construction to better characterize the extent and type of contamination. Any contaminated soils encountered during construction will be removed and disposed of at existing upland facilities permitted to accept contaminated waste. Contaminated material will be transported by trucks using existing haul routes, such as state highways. The contractor will provide bills of lading to the Washington State Department of Transportation (WSDOT) to ensure that contaminated materials have been disposed of properly.

Marbled murrelet monitoring will be conducted according to the approved Service protocols during all impact pile driving activities. Pile driving will be stopped if marbled murrelets are present within the area of potential injury and will only resume after the bird(s) have left the area of their own volition. Please refer to Appendix A for the complete Marbled Murrelet Monitoring Plan.

A bubble curtain or other device providing equivalent or better sound attenuation will be used during impact pile driving of 24-inch- and 30-inch-diameter steel piles, when possible. Due to tidal fluctuations and the shallow location of many of the piles, it may not be feasible to use a bubble curtain or other similar attenuation device on all of the piles.

Hydroacoustic monitoring will be conducted during impact installation of two 24-inch-diameter steel piles, three 30-inch-diameter steel piles, and three 12-inch steel H-piles. Airborne monitoring of noise levels of the impact driving will also be conducted. Please refer to Appendix B for the complete Hydroacoustic Monitoring Plan.

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 for this proposed federal action is based on the geographic extent of underwater sound during impact pile driving of steel piles, as depicted in Figure 2.

The farthest reaching impacts result from pile driving in the marine environment. Underwater noise levels during impact driving of 30-inch-diameter steel piles are estimated to be 195 dB root mean square (RMS) re: 1 micropascal (μPa) (WSDOT 2007). Using the practical spreading loss model, the distance at which impact pile driving noise will attenuate to background levels (122 dB_{RMS} re: 1 μPa) is approximately 457 miles or the nearest landform within that distance. Due to the proximity of landforms, the action area boundaries remain identical to those described in the 2013 Opinion.

Impact driving of steel piles will also generate the farthest reaching impacts on land and over water. In-air noise due to impact hammer operation will attenuate to background levels at a distance of 1.68 miles over water and 0.60 mile over land.

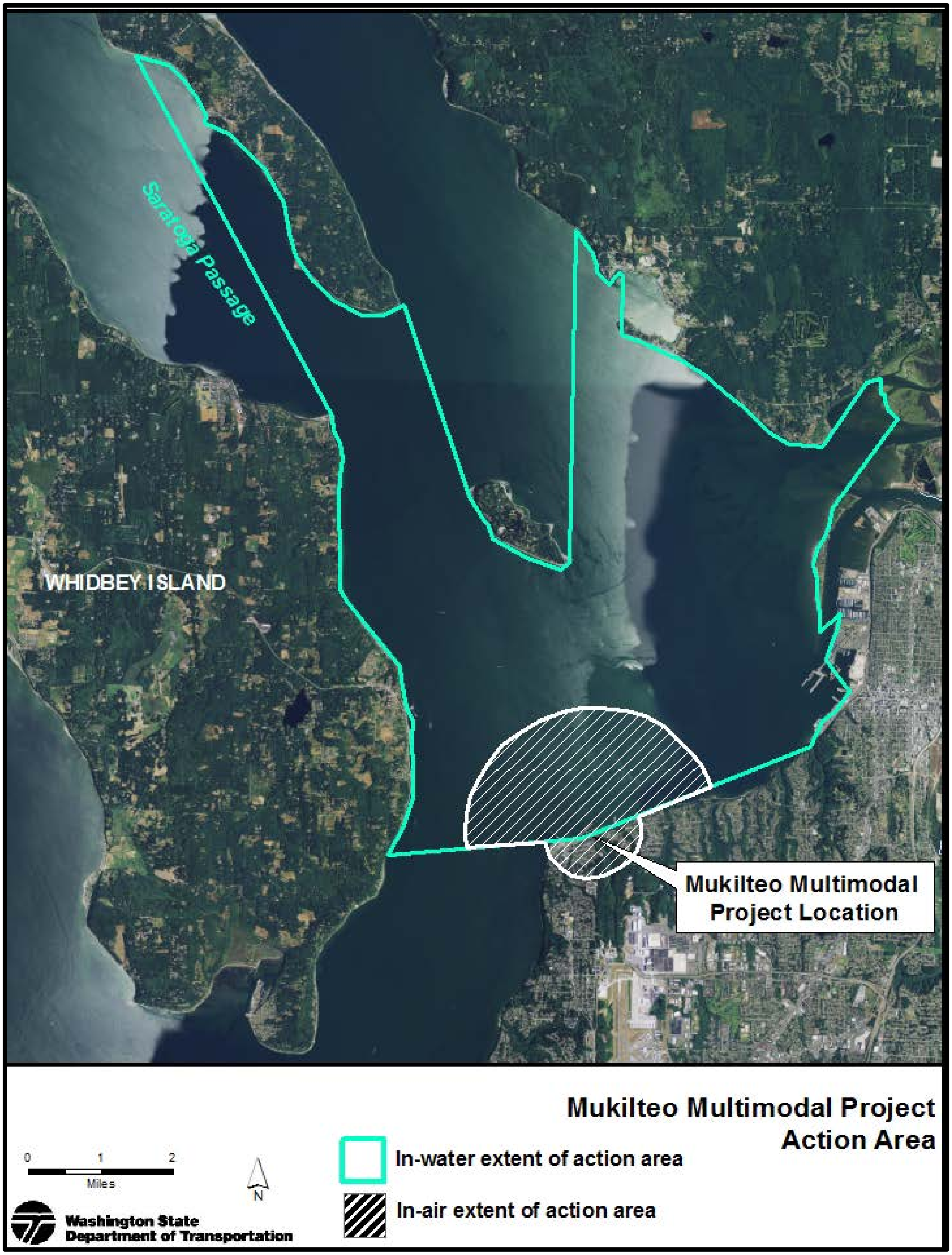

Figure 2. Action area for the Mukilteo Multimodal Project

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Jeopardy Determination

The following analysis relies on the following four components: (1) the Status of the Species, which evaluates the rangewide condition of the listed species addressed, the factors responsible for that condition, and the species' survival and recovery needs; (2) the Environmental Baseline, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) Cumulative Effects, which evaluates the effects of future, non-federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed federal action in the context of the species' current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of listed species in the wild.

The jeopardy analysis in this Opinion emphasizes the rangewide survival and recovery needs of the listed species and the role of the action area in providing for those needs. It is within this context that we evaluate the significance of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

Section 7(a)(2) of the Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to destroy or to adversely modify designated critical habitat. A final rule revising the regulatory definition of "destruction or adverse modification of critical habitat" was published on February 11, 2016 (81 FR 7214). The final rule became effective on March 14, 2016. The revised definition states: "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."

Past designations of critical habitat have used the terms "primary constituent elements" (PCEs), "physical or biological features" (PBFs) or "essential features" to characterize the key components of critical habitat that provide for the conservation of the listed species. The new critical habitat regulations (79 FR 27066) discontinue use of the terms "PCEs" or "essential features," and rely exclusively on use of the term "PBFs" for that purpose because that term is contained in the statute. However, the shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs or essential features. For those reasons,

in this biological opinion, references to PCEs or essential features should be viewed as synonymous with PBFs. All of these terms characterize the key components of critical habitat that provide for the conservation of the listed species.

Our analysis for destruction or adverse modification of critical habitat relies on the following four components: (1) the Status of Critical Habitat, which evaluates the range-wide condition of designated critical habitat for the bull trout and marbled murrelet in terms of essential features, PCEs, or PBFs, depending on which of these terms was relied upon in the designation, the factors responsible for that condition, and the intended recovery function of the critical habitat overall; (2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the essential features, PCEs, or PBFs and how those effects are likely to influence the recovery role of affected critical habitat units; and (4) Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the essential features, PCEs, or PBFs and how those effects are likely to influence the recovery role of affected critical habitat units.

For purposes of making the destruction or adverse modification finding, the effects of the proposed Federal action, together with any cumulative effects, are evaluated to determine if the critical habitat rangewide would remain functional (or retain the current ability for the PBFs to be functionally re-established in areas of currently unsuitable but capable habitat) to serve its intended conservation/recovery role for the bull trout.

STATUS OF THE SPECIES: Marbled Murrelet

For a detailed account of marbled murrelet biology, life history, threats, demography, and conservation needs, refer to Appendix C: Status of the Species: Marbled Murrelet.

STATUS OF THE SPECIES: Bull Trout

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

STATUS OF CRITICAL HABITAT: Bull Trout

For a detailed account of the status of the designated bull trout critical habitat, refer to Appendix E: Status of the Species: Bull Trout Critical Habitat.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all federal, state, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed federal projects in the action area that have undergone section 7 consultation, and the impacts of state and private actions which are contemporaneous with the consultation in progress.

Environmental baseline information for the Mukilteo Ferry Terminal is provided in the 2013 Biological Opinion. Additional information is provided below.

Current Condition of the Species in the Action Area: Marbled Murrelet

The action area for this project is located in Conservation Zone 1 within Stratum 3 (south Hood Canal, central/south Puget Sound, and the mainland between Puget Sound and the Canadian border). Within all of Conservation Zone 1, which encompasses all of Puget Sound and the Strait of Juan de Fuca, marbled murrelets tend to forage in well-defined areas during the breeding season. They are found in the highest densities in the nearshore waters of the San Juan Islands, Rosario Strait, the Strait of Juan de Fuca, Admiralty Inlet, and Hood Canal. They are more sparsely distributed elsewhere in Puget Sound, with smaller numbers observed during different seasons within the Nisqually Reach, Possession Sound, Skagit Bay, Bellingham Bay, and along the eastern shores of Georgia Strait. During the non-breeding season, they typically disperse and are found farther from shore (Strachan et al. 1995).

The latest population estimates for Conservation Zone 1 were based on at-sea surveys conducted by the Washington Department of Fish and Wildlife (WDFW) in 2015 as part of the Northwest Forest Plan (NWFP) Effectiveness Monitoring Program. These surveys are conducted in designated Primary Sampling Units within 2 to 5 km of shore from mid-May through the end of July, when breeding marbled murrelets at sea are likely to be associated with inland nesting habitat. In 2016, the population for Conservation Zone 1, Stratum 3 (the stratum that includes the action area), was estimated to be 362 marbled murrelets (95 percent confidence interval: 106 to 621), at a density of 0.249 birds per square km (Lynch et al. 2017, p. 12). In 2015, only 1 marbled murrelet was detected during surveys in Stratum 3, and the population for this stratum was estimated to be 94 marbled murrelets (upper bound of 95 percent confidence interval was 261), the lowest number since effectiveness monitoring began in 2000 (Lynch et al. 2016 pp. 4 and 13). Estimated at-sea densities of marbled murrelets in Stratum 3 in the last few years range from 1.097 birds per square km in 2013 to 0.064 birds per square km in 2015 (Lynch et al. 2016 p. 13). Within Stratum 3, the area surrounding Hat Island (approximately 4 miles due north of Mukilteo) was surveyed as a Primary Sampling Unit, and this unit was estimated to have densities of one to three birds per square km between 2009 and 2014 (Marbled Murrelet Effectiveness Monitoring Module 2015). While PSU-level estimates are not intended to be used individually for analysis as they may have large confidence intervals, the PSU-level data are useful for indicating general patterns of marbled murrelet density. The estimated rate of population change in Conservation Zone 1 as a whole indicates a declining trend at an average rate of -4.9 percent (95 percent confidence interval -7.7 percent to -2.1 percent) per year for the period from 2001 to 2015 (Lynch et al. 2017, p. 8).

The WDFW conducted surveys on behalf of the U.S. Navy to determine on-the-water marbled murrelet densities during the fall through spring seasons in areas of Puget Sound near naval facilities, using the same survey methods as the NWFP Effectiveness Monitoring program. The survey area covering the Whidbey Basin (the Saratoga Passage, Port Susan, and Possession Sound) includes the action area. The results from the 2015 through 2016 survey season showed an estimated density of 1.222 birds per square kilometer in the Whidbey Basin survey area, with the period of the highest estimated density during the fall through spring survey season occurring from November through mid-December (Pearson and Lance 2016, Table 2). The results from the sampling unit immediately adjacent to and including the project footprint indicated a much lower estimated density of marbled murrelets (0.130 birds per square kilometer) than the Whidbey Basin survey area as a whole (Pearson and Lance 2016, Tables 2 and 3).

Marbled murrelets are known to forage in the marine nearshore areas of the Mukilteo Ferry Terminal, and are regularly found near the existing ferry terminal and the Mukilteo Lighthouse during the summer months (April through August), approximately 1,300 feet west of the proposed ferry terminal, as well as around 500 m northeast (eBird 2017). They are also found in this area intermittently at other times of the year. Marbled murrelets were observed foraging in marine nearshore habitat near Elliott Point in January 2005 (ESA Adolfson 2006).

According to the WDFW Priority Habitat database, no marbled murrelet nest sites or suitable terrestrial habitat are known to occur within 0.25 mile of the ferry terminal area (WDFW 2017). The closest recorded occupied site is more than 10 miles from the ferry terminal, and therefore outside of the action area (WDFW 2017). In addition, suitable nest trees do not exist in forested areas within 1 mile or more of the ferry terminal (ESA Adolfson 2006). Because there is no suitable nesting habitat in the project area and sound from construction activities will not extend into stands that may be suitable habitat, effects to nesting marbled murrelets are considered discountable.

The action area provides suitable marine habitat for marbled murrelet and could be used year-round for foraging, loafing (resting, preening), courtship behaviors, rearing, or social interactions between adults and/or fledglings. Marbled murrelets spend the majority of their lives in marine areas, usually within 1.2 miles (2 km) of the shoreline, as this is where forage fish and other marine prey resources are most abundant (USFWS 1997, p. 120).

Forage fish make up a significant portion of the diets of marbled murrelets, and are loosely defined as small, schooling fishes. Three common species in Puget Sound are surf smelt (*Hypomesus pretiosus*), Pacific sand lance (*Ammodytes hexapterus*) (sand lance), and Pacific herring (*Clupia pallasii*) (herring). There are no documented spawning areas for these forage fish species at the proposed new ferry terminal, although sand lance spawning has been documented at the existing ferry terminal. Sand lance spawning has also been documented 0.3 mile northeast of the proposed ferry terminal in front of the Silver Cloud Inn near Edgewater Beach (WDFW 2016). Forage fish spawning has also been documented in portions of the action area at greater distances from the project footprint, including along the shoreline of Whidbey Island (surf smelt and sand lance), Hat Island (sand lance), and Camano Island (surf smelt, sand lance, and herring), and along the shoreline of the mainland from Tulalip Bay, north (surf smelt and herring) (WDFW 2016).

Conservation Role of the Action Area: Marbled Murrelet

The action area provides foraging habitat for marbled murrelets, and during the nesting season, could potentially serve as a concentration area for a small number of breeding marbled murrelets.

As outlined by the Recovery Plan (USFWS 1997, p. 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 (Becker and Beissinger 2003, pp. 251–252). 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 2012, 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 2012, p. 13).

There are threats in the action area that need to be addressed to assist in maintaining self-sustaining populations of marbled murrelets in this geographic area. These threats include oil spills, disturbance from vessel traffic in marine areas, and impacts to prey resources from habitat degradation, many of which are direct results of increasing human populations, shoreline development, and effects from climate change.

Rising human population has increased shoreline development and vessel traffic, which have degraded nearshore marine habitat. There are high levels of vessel traffic and shoreline development in the action area compared to other areas in Conservation Zone 1. Disturbance from vessel traffic could be detrimental to marbled murrelets in areas where prey resources are scarce and birds must fly great distances inland to nesting sites (Speckman et al. 2004, p. 33). Urban sprawl, logging and habitat fragmentation in the lowland forested areas has resulted in marbled murrelets needing to travel greater distances to reach mature forests and suitable nesting habitat. Shoreline development and human development along the coast and nearshore marine areas of Puget Sound have degraded forage fish spawning habitat and intertidal habitat. These threats combined with the other unaddressed range-wide threats could affect the long-term survival of marbled murrelets.

Climate Change

Our analyses under the Act 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). Various types of changes in climate can have direct or indirect effects on species. These effects

may be positive, neutral, or negative; and they may change over time. The nature of the effect depends on the species, the magnitude and speed of climate change, and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2014b, pp. 64, 67–69, 94, 299). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

During the next 20 to 40 years, the climate of the Pacific Northwest is projected to change significantly with associated changes to forested ecosystems. Predicted changes include warmer, drier summers and warmer, wetter autumns and winters, resulting in diminished snowpack, earlier snowmelt, and an increase in extreme heat waves and precipitation events (Salathé et al. 2010). Initially, the Pacific Northwest is likely to see increased forest growth region-wide over the next few decades due to increased winter precipitation and longer growing seasons; however, forest growth is expected to decrease as temperatures increase and trees can no longer benefit from the increased winter precipitation and longer growing seasons (Littell et al. 2009, p. 15). Additionally, the changing climate will likely alter forest ecosystems as a result of the frequency, duration, and timing of disturbance factors such as fire, drought, introduced species, insect outbreaks, landslides, and flooding (Littell et al. 2009).

One of the largest projected effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration, and severity. In general, wet western forests have short dry summers and high fuel moisture levels that result in very low fire frequencies. However, high fuel accumulations and forest densities create the potential for fires of very high intensity and severity when fuels are dry (Mote et al. 2008, p. 23). Westerling et al. (2006) looked at a much larger area in the western United States including the Pacific Northwest, and found that since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period 1970 to 1986. The total area burned is more than 6.5 times the previous level and the average length of the fire season during 1987 to 2003 was 78 days longer compared to 1978 to 1986 (Westerling et al. 2006, p. 941). Littell et al. (2009, p. 2) project that the area burned by fire in the Pacific Northwest will double by the 2040s and triple by the 2080s.

Refer to the 2013 Biological Opinion for additional detail on climate change impacts on listed species in the action area.

For information on the conservation role of the action area for bull trout, refer to the 2013 Opinion.

Current Condition of the Bull Trout and Bull Trout Critical Habitat in the Action Area

Refer to the 2013 Biological Opinion.

Previously Consulted-On Effects

The Service has consulted on recent projects in Puget Sound since the 2013 Biological Opinion was completed, including the U.S. Navy's Northwest Training and Testing Program (2016), the 2017 – 2036 Puget Sound Treaty and Non-Treaty (All-Citizen) Salmon Fisheries (2017), and numerous other smaller projects.

EFFECTS OF THE ACTION: Marbled Murrelet

The effects of the action 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 (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

Direct effects on marbled murrelet from this project could occur from in-air and in-water noise; temporary, localized increases in turbidity; and possible contaminant release from creosote treated pile removal. Indirect effects include stormwater discharges and potential effects on prey species.

The sub-sections that follow discuss sequentially: insignificant and discountable effects (by project element and/or item of work); adverse effects to individuals (by project element and/or item of work); effects to the PCEs of critical habitat; and, a synthesis of effects and responses at the scale of the larger population(s). Some common potential stressors are discussed repeatedly (e.g., excess turbidity and sedimentation, effects to the prey base). Where analysis has not changed since the 2013 Biological Opinion, that document will be referenced. Refer to the 2013 Biological Opinion for the definition and explanation of stressors, exposures, responses, and effects.

Insignificant and Discountable Effects

<u>Overwater Cover/Shading</u>

As described in the 2013 Opinion, the new trestle and associated structures will create approximately 15,187 ft^2 of new overwater cover, and the new terminal building will increase overwater cover by 2,464 ft^2. The new fishing pier will result in an additional 3,975 ft^2 of overwater cover, which is an increase of 520 ft^2 from what was described in the 2013 Opinion. The project will create a total of 21,626 ft^2 post-construction overwater cover. For the fishing pier, a portion of this overwater coverage will be seasonal in nature. The area of permanent overwater coverage of the new fishing pier will be about 3,111 ft^2. Seasonal fishing pier floats for day moorage will be tied to the fishing pier between April and October of each year, covering approximately 864 ft^2. As a result, the total overwater cover associated with the fishing pier is 3,975 ft^2 (worst case). In addition, the project includes removing the old Tank Farm pier, which is approximately 150,238 ft^2 (3.45 acres) of existing overwater cover, the existing ferry terminal, and the existing fishing pier, for a net decrease of overwater cover by 128,612 ft^2 (approximately 3 acres).

Though the overwater cover generated by the proposed action will result in loss of marine habitat for marbled murrelets and shading impacts to nearshore forage fish habitat in perpetuity, the net reduction in overwater coverage within the action area will be an improvement over existing conditions. The bathymetry of the shoreline in the immediate vicinity of where new structures will be placed descends quickly to depths that exceed the limits of the photic zone and potential habitat for forage fish, further limiting the impact of overwater coverage in the project footprint

to forage fish habitat. As a result, the potential for these changes to measurably affect the marbled murrelet is considered insignificant; and the substantial net reduction of overwater cover within the action area may result in beneficial effects to habitat at the action area scale.

In addition, temporary shading will result from the use of barges during construction and from seasonal floats associated with the fishing pier. Shading associated with barges will be limited to a 7-month period during construction of the new terminal and removal of the existing ferry terminal. During the 7-month period, the barges will be moved regularly to access different work areas. Due to the temporary nature of the effects associated with barges, no significant effects to nearshore habitat function or forage fish habitat are anticipated, and as a result, these effects are considered insignificant to marbled murrelet.

Impacts to Benthic Habitat

Benthic areas provide habitat for forage fish that are a food source for marbled murrelets. Installation of piles and riprap slope protection for the project will negatively impact benthic habitat; however, removing existing creosote-treated timber piles may improve benthic habitat by removing a chronic source, via leaching, of polycyclic aromatic hydrocarbons (PAHs) and other chemicals, as well as reducing the footprint of structures that replace the natural benthic habitat.

The 2017 project description includes installation of 101 permanent piles below the MHHW mark (Table 1), not including the 135 ground stabilization H-piles or 4 floating dolphin anchor H-piles, which will be installed with the top of the H-piles below the mudline, allowing for benthic habitat to re-establish. The benthic impacts from the ground stabilization and floating dolphin anchor piles will therefore be considered temporary impacts. In addition, the project includes the installation of 161 temporary piles, including the 90 sheet piles for the stormwater outfall coffer dam that will be below MHHW (Table 1). The new in-water slope protection design will require the placement of riprap over an area of 1,700 ft^2. WSF does not propose to remove riprap at the existing terminal.

The permanent and temporary loss of nearshore benthic habitat will degrade natural habitats within the project footprint by removing native substrate and the associated epibenthic and infaunal communities, and by permanently replacing natural forms of habitat structure with piles in the case of the permanent piles installed. Tables 2 and 3 show the areas of permanent and temporary benthic impacts for the revised 2017 project description.

Table 2. Area of permanent benthic impacts for the Mukilteo Multimodal Project Phase II

Structure	Depth (MLLW)	2013 BO (ft^2)	2017 Revised Design (ft^2)	Change (ft^2)	Change Summary
Trestle and Terminal Building	+11.5 to -5	69	123	54	Previous: 22 concrete piles (24 inch) PROPOSED: 25 steel piles (30 inch)
Vehicle Transfer Span	+5 to -35	39	66	27	Previous: 2 drilled steel shafts (60 inch) PROPOSED: 2 drilled shafts (78 inch)
Overhead Loading	0 to -38	94	108	14	Previous: 1 drilled steel shaft (131 inch) PROPOSED: 3 steel piles (30 inch) 1 drilled steel shaft (131 inch)
Wingwalls (2)	-37	32	105	73	Previous: 18 steel piles (18 inch) PROPOSED: 20 steel piles (24 inch) 6 steel piles (36 inch)
Dolphins (2)	-35 to -38	88	91	3	Previous: 18 steel piles (30 inch) PROPOSED: 10 steel piles (30 inch) 6 steel piles (36 inch)
Public Fishing Pier	+11.10 to -35	50	88	38	Previous: 12 concrete piles (24 inch) 15 steel piles (12 inch) PROPOSED: 28 steel piles (24 inch)
In-Water Slope Protection	-24 to -35	N/A	1,700	1,700	Riprap added to protect the slope within the slip. RBA acknowledged loss of epibenthic productivity in the slip area due to ongoing propeller wash
Total Impacts (square feet)		**372**	**2,281**	**1,909**	**Proposed design will impact additional 1,909 ft^2 compared to 2013 design**

Table 3. Area of temporary benthic impacts for the Mukilteo Multimodal Project Phase II

Structure	Depth (MLLW)	2013 BO (ft^2)	2017 Revised Design (ft^2)	Change (ft^2)	Description
Stormwater Outfall Coffer Dam (if necessary)	MHHW to -4	N/A	120	120	PROPOSED: 30 ft by 40 ft. This area includes the sheet piles and all soil removed from within the coffer dam sheet pile walls
Temporary Piles for Construction	MHHW to -40	N/A	214	214	PROPOSED: Up to 68 temporary piles could be used to construct the overhead loading structure
Floating Dolphin Anchors	-24 to -35	N/A	4	4	Previous: Possibly 6 steel H-piles but details not provided PROPOSED: 4 steel H-piles
Ground Improvements	-24 to -35	25,000	135	-24,865	Previous: 200 stone columns (3 ft) over 25,000 ft^2 PROPOSED: 135 steel H-piles
Total Temporary Benthic Impacts		**25,000**	**473**	**-24,527**	**Proposed design will have an area of temporary impacts 24,527 ft^2 smaller than 2013 design**

In addition to the negative impacts on benthic habitat from pile and riprap installation, the project includes the removal of 290 piles associated with the existing terminal and fishing pier and has already removed 3,930 Tank Farm Pier piles, which will result in a total of 3,315 ft^2 increase in area for potential benthic habitat establishment, none of which will be shaded by overwater structures. Consequently, the project will result in a 1,034 ft^2 net gain in potential permanent benthic habitat that will allow for the establishment of additional benthic macroalgae and macroinvertebrates throughout the action area and potential improvements in available forage fish spawning habitat. In, particular, documented sand lance spawning habitat located adjacent to the existing terminal will benefit from the benthic improvements where the terminal will be removed.

We do not expect that permanent features of the project will prevent or discourage the use of habitat in the action area by forage fish. Because of the small amount of the negatively affected habitat in the action area, and because productive, alternative foraging opportunities are readily available, we conclude that the temporary adverse effects to benthic habitat will not significantly impact forage fish populations. The anticipated long-term beneficial effects to benthic habitat produced by the project will result in slight improvements of available habitat and habitat quality within the action area, but these changes are not expected to measurably affect marbled murrelet prey base, and are therefore insignificant.

Temporary Exposure to Elevated Turbidity, Contaminants, and Degraded Water Quality

Installation and removal of piles and placement of riprap will result in temporary impacts to water quality. Based on the RBA, during vibratory and impact driving or removal of piles, increased turbidity and/or resuspended contaminants surrounding the piles will be confined to within 150 ft.

As described in the 2013 Opinion, the limited PAH concentration information available for the project site and limited contaminant sampling in upland soils, groundwater, and nearshore sediments makes it difficult to predict with any accuracy what concentrations of contaminants will be in surface waters and sediments during installation or removal of piles and riprap. It is reasonable to assume contaminant 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, pile installation, and riprap placement activities, throughout the entire duration of these activities, as a result of resuspension of contaminated sediments and potentially pooled creosote. It is also reasonable to assume that there will be short- and long-term elevated concentrations of contaminants in surface sediments in the vicinity of piles or riprap.

Pile removal is the project activity likely to create the greatest risk of exposure to elevated turbidity. Removal of 168 temporary piles associated with construction of the proposed facility will occur for 44.25 hours over 39 days during the approved in-water work window (August 1, 2017, through February 15, 2018, and November 2018 through February 15, 2019, for sheet piles associated with the coffer dam). For the existing terminal and fishing pier, pile removal activities will occur for 73 hours over a period of 2 weeks during the in-water work window (December 2019 to February 15, 2020), as described in the 2013 Opinion.

Pile installation may also result in exposure to elevated turbidity and contaminants, although to a lesser extent than pile removal, and has increased from the 288 piles and stone columns in the 2013 Opinion. Vibratory installation of 401 steel piles will occur for 1 to 5 hours per day over 104 days, and impact driving of 98 steel piles will occur for 45 minutes to 5.25 hours per day over 34 days, both during the approved in-water work window (August 1, 2017, through February 15, 2018, and November 2018 through February 15, 2019, for sheet piles associated with the coffer dam).

Additional riprap will be placed over an area of approximately 1,700 ft^2 for the in-water slope protection from propeller wash. This work will occur over approximately 3 to 4 weeks. We assume that increased turbidity and/or resuspended contaminants surrounding the locations of riprap placement will be confined to within 150 ft of the riprap, similar to the estimates for pile removal and installation.

There is limited literature documenting the effect of sediment on forage fish in the marine environment. Forage fish spawn and rear along naturally turbid shorelines and are frequently exposed to natural sediment plumes entering Puget Sound via freshwater tributary streams (USFWS 2008, p. 19). We do not expect temporary turbidity or suspension of sediments and the permanent habitat alterations to impact the marbled murrelet prey base to a measurable extent.

Direct exposure to elevated PAH or contaminant levels in the water column would be limited temporally and spatially to the extent specified above for turbidity. 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 and installation activities and riprap placement activities. Foraging marbled murrelets cover large areas of shoreline and are not expected to remain in close proximity (within 150 ft) of the proposed new ferry terminal for prolonged periods of time during construction. As a result, potential short or long-term exposures to elevated concentrations of contaminants in the water column or via the food web at this location are considered insignificant. At the existing ferry terminal, suitable forage fish habitat is present. As a result, direct exposure to creosote related contaminants at the existing ferry terminal is possible, but will be limited in duration (73 hours over 2 weeks), and to within 150 ft of the existing structure. The Service expects that any short-term effects from exposure to creosote from piling removal will be immeasurable and therefore considered insignificant. 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 short duration of exposures, we do not expect the marbled murrelet prey base to be affected to a measurable extent.

Stormwater

Refer to the 2013 Biological Opinion for a detailed description of the primary pollutants of concern generated from stormwater and behavioral thresholds for fish.

Given the changes in the project design for PGIS and stormwater treatment, pollutant loads and concentrations for the project were reanalyzed using the HI-RUN program approved by WSDOT and the Services per the 2009 Memorandum of Agreement. Existing PGIS in the project footprint includes 8.1 acres and the 2017 project design will create an additional 0.8 acre, for a total of 8.9 acres. Of this, 1.1 acre will be treated by infiltration and 7.8 acres will discharge to the 24-inch storm drain outfall that is within Park Avenue and a new outfall located east of the terminal building. Enhanced treatment will be provided for all stormwater generated on site, including infiltrated stormwater. In addition, WSF will sweep the holding areas and PGIS on a quarterly basis with a high-efficiency vacuum sweeper (as described in the 2013 Biological Opinion), which will reduce pollutants entering stormwater. The level of reduction this vacuuming will generate is difficult to quantify and was not included in the HI-RUN analysis, but will positively contribute to a source reduction of potential stormwater runoff pollutants. As such, the HI-RUN model provides a conservative estimate of project stormwater impacts. Pre- and post-project pollutant loads and concentrations for the 7.8 acres of discharged stormwater are shown in Table 4 and Table 5, respectively.

Table 4. Pre- and post-project pollutant loads for the Mukilteo Multimodal Project

Outfall	Scenario	Median Pollutant Load (lb/year)[1]				
		TSS	TCu	DCu	TZn	DZn
Park Avenue	Existing	611	0.16	0.042	0.963	0.295
	Proposed	56	0.048	0.03	0.23	0.15
	Difference	-555	-0.112	-0.012	-0.733	-0.145
	Percent change	-90.8%	-70%	-28.6%	-76.1%	-49.2%
New Outfall	Existing	0	0	0	0	0
	Proposed	233	0.2	0.12	0.95	0.63
	Difference	+233	+0.2	+0.12	+0.95	+0.63
	Percent Change	N/A	N/A	N/A	N/A	N/A

[1] TSS = total suspended solids; TCu = total copper; DCu = dissolved copper; TZn = Total zinc; DZn = dissolved zinc.

Table 5. Pre- and post-project pollutant concentrations for the Mukilteo Multimodal Project

Outfall	Scenario	Median Pollutant Concentration (mg/L)				
		TSS	TCu	DCu	TZn	DZn
Park Avenue	Existing	54.378	0.014	0.004	0.086	0.026
	Proposed	5.627	0.005	0.003	0.023	0.016
	Percent change	-89.7%	-64.3%	-25%	-73.3%	-38.5%
New Outfall	Existing	0	0	0	0	0
	Proposed	5.689	0.006	0.003	0.03	0.017
	Percent change	N/A	N/A	N/A	N/A	N/A

No updated analysis of dilution zones was provided for the new stormwater design. Using the CORMIX results provided in the 2013 Opinion as a worst-case scenario, the distance at which dissolved copper (DCu) in stormwater discharge dilutes to 2 ug/L above the background concentration and dissolved zinc (DZn) dilutes to 5.6 ug/L above background concentrations is assumed to be within 50 ft of the outfalls.

The 2017 stormwater treatment design results in substantial decreased annual loadings of most stormwater constituents discharged into Possession Sound compared to the stormwater design in the 2013 Opinion (Table 6). Although baseline conditions will be slightly worsened in the vicinity of the ferry terminal because of the creation of new PGIS and a new outfall, and the resultant increase in annual loadings of stormwater constituents, the enhanced treatment provided to all stormwater generated on site provides a slight improvement.

Table 6. Pollutant load comparison from 2013 to 2017 for the Mukilteo Multimodal Project Phase II

	TSS	**TCu**	**DCu**	**TZn**	**DZn**
2013 Stormwater Treatment Design	518	0.329	0.199	1.18	1.03
2017 Stormwater Treatment Design	289	0.248	0.15	1.18	0.78
Difference	-229	-0.081	-0.049	0	-0.25
Percent Change	-44.2%	-24.6%	-24.6%	0	-24.3%

Given the limited extent of habitat for forage fish in the project footprint, the small scale of these adverse stormwater impacts generated by the project when compared to current conditions, and the limited frequency, duration, and intensity of potential exposures, we expect that the stormwater discharges will have no measurable effect on marbled murrelet individuals or their prey base, and are therefore insignificant.

Prey Base Reduction Due to Elevated Underwater Sound

Both vibratory and impact pile driving produce elevated underwater sound pressure level (SPLs) that can affect fish, including forage fish that make up the prey base for marbled murrelets. While impact pile driving creates SPLs at frequencies and intensities that have been documented to injure and kill fish, vibratory drivers produce, on average, underwater peak pressures that are approximately 17 decibels (dB) lower than those generated by impact hammers (Nedwell and Edwards 2002). Underwater sound produced by vibratory and impact hammers differs not only in intensity, but also in frequency and impulse energy (i.e., total energy content of the pressure wave). This may explain why no documented fish kills have been associated with the use of vibratory hammers. Most of the sound energy produced by impact hammers is concentrated at frequencies between 100 and 800 hertz (Hz), the frequencies thought to be most harmful to exposed aquatic organisms, while sound energy produced by vibratory hammers is concentrated between 20 and 30 Hz (Teachout, *in litt.* 2010, p. 15). In addition, sound pressures produced by vibratory hammers do not rise as rapidly as the sound pressures produced by impact hammers (Carlson et al. 2001; Nedwell and Edwards 2002). Therefore, the Service does not consider vibratory noise to have injurious effects on forage fish.

We do expect impact pile driving to result in short-term adverse effects to forage fish. Impact pile driving can cause levels of underwater sound sufficient to injure or kill fish and alter their behavior (Hastings 1995, p. 3; Hastings and Popper 2005, p. 34; Turnpenny and Nedwell 1994, pp. 5–7; Popper et al. 2013, pp. 28–29). Death can be instantaneous, occur within minutes after exposure, or occur several days later. Even if fish are not immediately killed, these injuries can affect survival and fitness. Fish will be exposed to underwater sound pressures that will exceed the thresholds for injury established by the Fish Hydroacoustic Working Group (FHWG 2008), which include 183 dB_{SEL} re: 1 μPa^2s for fish smaller than 2 grams and 187 dB_{SEL} re: 1 μPa^2s for fish greater than 2 grams in mass.

We use the practical spreading model (Davidson 2004) to estimate the distance from pile installation operations at which transmission loss can be expected to attenuate SPL and sound exposure levels (SEL) to below thresholds for injury and significant behavioral interference. The calculation [transmission loss = 15*Log(R)] assumes that sound levels decrease at a rate of 4.5 dB per doubling distance. This method also assumes that single-strike SELs less than 150 dB do not accumulate to cause injury ("effective quiet") (Stadler 2009). Based on estimated pile driving noise levels provided by the WSF (sources are indicated in Table 7), we used a single-strike SPL of 206 dB_{peak} re: 1 µPa and 195 dB_{RMS} re: 1 µPa, and a single-strike SEL of 180 dB re: 1 $\mu Pa^2 s$. Construction of the trestle structure may require a worst-case scenario of 3,000 strikes per pile for impact driving the 25 steel piles. To calculate impact levels for the project as a whole, we assumed as many as 9,000 strikes per day (three piles per day, 3,000 strikes per pile for all project piles), installed by one pile driving crew during a single 10- or 12-hour workday. Although a bubble curtain will be deployed during impact pile driving when possible, due to tidal fluctuations and the shallow location of many of the piles, use of the bubble curtain will not be feasible in some cases. Consequently, an estimated attenuation for this BMP was not included in the practical spreading model in order to conservatively estimate impacts. These assumptions regarding unattenuated pressures are within the range reported in the literature for similar operations (CALTRANS 2007). Given the estimated noise levels, the worst-case scenario for the number of pile strikes per day, and no attenuation included for use of the bubble curtain, the result is a potential area of injury for fish of 1,000 m (0.62 mile) from pile driving operations and 10,000 m (6.21 miles) from pile driving operations for potential behavioral effects to fish.

However, the majority of piles that will be impact driven will require only 300 strikes per pile. If the 25 piles for the trestle that require up to 3,000 strikes per pile are separated from the rest of the project, the remaining 73 piles will be impact driven during the winter (October through March) with a maximum of 300 strikes per pile. Using the same estimated noise levels as above, assuming zero dB attenuation from the bubble curtain, and assuming 900 strikes per day (three piles per day, 300 strikes per pile) for one pile driving crew, the result is a much smaller potential area of injury of 588 m (0.37 mile) from pile driving operations for fish smaller than or equal to 2 grams, and 318 m (0.20 mile) for fish greater than 2 grams. For fish both smaller than and greater than 2 grams, the distance for potential behavioral responses extends to 10,000 m (6.21 miles).

These elevated SPLs at the level of disturbance or injury will be temporary and intermittent, corresponding to approximately 45 minutes to 5.25 hours per work day when installing steel piles with an impact pile driver. The approximate hours per work day of impact pile driving was determined by taking the minimum time of impact driving per pile (15 minutes) and maximum time of impact driving per pile (105 minutes) based on estimated times provided by the WSF, and then multiplying by the maximum number of piles per day (3 piles). The number of piles for each structure and the number of strikes for impact pile driving is summarized in Table 7.

Table 7. In-water pile driving summary for the Mukilteo Multimodal Project Phase II

Method	Project Element	Pile Type and Diameter (inches)	Estimated Noise Level	Number of Piles	Strikes per Pile	Duration (days)
Vibratory Driving	Overhead loading structure (temporary piles), wingwalls, fishing pier, and fishing pier barge mooring site (temporary pile)	Steel 24	162 dB_{RMS}[1]	117	N/A	39
Impact Driving	Overhead loading structure (temporary piles)	Steel 24	199 dB_{PEAK}[2] 174 dB_{SEL} 189 dB_{RMS}	68	300	23
Vibratory Removal	Overhead loading structure (temporary piles), fishing pier barge mooring site (temporary pile)	Steel 24	162 dB_{RMS}[1]	69	N/A	23
Vibratory Driving	Trestle and terminal building, dolphins, overhead loading structure, and 2 temporary test piles	Steel 30	174 dB_{RMS}[3]	40	N/A	14
Vibratory Removal	Inner dolphin and 2 temporary test piles	Steel 30	174 dB_{RMS}	9	N/A	1
Impact Driving	Trestle structure	Steel 30	206 dB_{PEAK}[4] 180 dB_{SEL} 195 dB_{RMS}	25	3,000	9
Impact Driving	Overhead loading structure and 2 temporary test piles	Steel 30	206 dB_{PEAK}[4] 180 dB_{SEL} 195 dB_{RMS}	5	300	2
Vibratory Driving	Dolphins and wingwalls	Steel 36	177 dB_{RMS}	12	N/A	4
Vibratory Driving	Vehicle transfer span	Steel 78	166 dB_{RMS}[5]	2	N/A	2
Vibratory Driving	Overhead loading structure	Steel 120	166 dB_{RMS}[6]	1	N/A	1
Vibratory Driving	Ground stabilization and floating dolphin anchors	Steel H-pile	150 dB_{RMS}[5]	139	N/A	14

Table 7. In-water pile driving summary for the Mukilteo Multimodal Project Phase II – Continued

Method	Project Element	Pile Type and Diameter (inches)	Estimated Noise Level	Number of Piles	Strikes per Pile	Duration (days)
Vibratory Driving	Stormwater outfall coffer dam	Steel Sheet	164 dB_{RMS}[7]	90	N/A	30
Vibratory Removal	Stormwater outfall coffer dam	Steel Sheet	164 dB_{RMS}	90	N/A	15
Total				**Vibratory Drive 401** **Impact Drive 98** **Vibratory Removal 168**		**177**

[1] Revised Friday Harbor Vibratory Pile Monitoring Technical Memorandum. WSDOT Office of Air Quality and Noise. March 2010. Vibratory removal is assumed to generate the same estimated noise level.

[2] Vashon Acoustic Monitoring. E-mail from Jim Laughlin (WSDOT) to Rick Huey (WSF). WSDOT Office of Air Quality and Noise. September 10, 2015.

[3] Port Townsend Test Pile Project: Underwater Noise Monitoring Draft Final Report. WSDOT Office of Air Quality and Noise. November 10, 2010.

[4] Underwater Sound Levels Associated with Driving Steel and Concrete Piles Near the Mukilteo Ferry Terminal. WSDOT Office of Air Quality and Noise. March 2007.

[5] Compendium of Pile Driving Sound Data. California Department of Transportation. September 27, 2007.

[6] Underwater Sound Levels Associated with Driving 72 inch Steel Piles at the SR 529 Ebey Slough Bridge Replacement Project. WSDOT Office of Air Quality and Noise. March 2011.

[7] Elliott Bay Seawall Project Season 2 (2015) Revised Acoustic Monitoring Report. October 9, 2015. Vibratory removal is assumed to generate the same estimated noise level.

Although forage fish will be exposed to SPLs sufficient to cause injury and mortality, this injury and mortality will not translate to any measureable effects to marbled murrelets. There is forage fish spawning habitat within the injury zone, and forage fish are expected to be present; however, given the relatively small area of marine habitat affected by injurious levels of in-water sound, we expect that loss of individual forage fish will not be measurable compared to the larger forage fish population present in the vicinity. Because the loss of individual forage fish during impact pile driving within the in-water work window will not be discernable at a population scale, we do not expect the forage base to be significantly affected such that marbled murrelet foraging opportunities would be significantly diminished or require increased energetic cost. Therefore we find no significant effect to marbled murrelets as a result of short-term limited decrease in forage fish in an area where marbled murrelets forage.

Operational Noise

In the long term, operation of the ferry terminal will result in ongoing noise impacts within the action area associated with ferry boats. Despite an increase in anticipated ridership in the future, there is not a direct correlation between increased ridership and increased ferry trips for the following reason: the multimodal functions of the new terminal will allow for more efficient use

of the ferry by non-vehicle commuters and public transit users, and the larger ferries that will be supported by the new terminal facilities will accommodate a larger number of vehicles per trip, limiting the total number of ferry trips per day to levels similar to current conditions. Noise levels associated with the new ferries are similar to and possibly lower than current ferry boats at the Mukilteo terminal.

As a result, noise levels generated by ferry traffic within the action area are anticipated to remain relatively constant, but the location of the noise will change from the existing ferry terminal and route to the proposed new terminal location and route (see Figure 2 in 2013 Biological Opinion). This change in location will not measurably alter baseline conditions or generate new impacts to marbled murrelets within the action area. Therefore, noise effects resulting from ongoing ferry operations are considered insignificant.

Adverse Effects of the Action

<u>Temporary Exposure to Elevated Underwater Sound Pressure Levels</u>

The sounds created by vibratory pile driving are different from impact installation (as described above under the Insignificant and Discountable Affects section) and the responses of marbled murrelets are also expected to differ. We expect marbled murrelets can hear the sounds produced by vibratory pile driving and that it could result in behavioral responses. However, vibratory pile driving is not expected to result in physical injury. Because the sound levels from vibratory pile driving are different than sound levels from impact pile driving, and because the sound will be intermittent and non-impulsive, we expect marbled murrelets will not be injured and will be able to continue foraging in the action area. Because effects to marbled murrelets from vibratory pile installation are considered to be insignificant, the remainder of the Opinion will only focus on the effects to the species associated with impact pile driving.

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 (National Institute of Health, in litt. 2011). The Service expects that the onset of injury

(hair cell loss) would occur at 202 dB cumulative SEL. This hair cell loss can be temporary or permanent, depending on exposure level. However, threshold shifts may occur at lower sound levels without resulting in physical injury to the individual. 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 Service 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 Service 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 202 dB cumulative SEL. Other physical injuries (i.e., barotrauma) could be expected when SELs meet or exceed 208 dB cumulative SEL. Injuries associated with barotrauma include death and/or hemorrhaging and rupture of internal organs. As used here, cumulative SEL is a metric for the total energy content of an impulsive sound event, or events. The energy that results from an impulsive sound event (in this case pile driving) is transmitted through both the substrate and the water column.

To calculate estimated areas of injury from impact pile driving, we determined the distance at which transmission loss attenuates sound to levels below thresholds for injury and significant behavioral interference. We use the practical spreading model and estimated pile driving noise levels provided by WSF, as described above in the section Prey Base Reduction Due to Elevated Underwater Sound. We used a single-strike SPL of 206 dBpeak re: 1 µPa and 195 dB_{RMS} re: 1 µPa, a single-strike SEL of 180 dB re: 1 $\mu Pa^2 s$, and assumed as many as 9,000 strikes per day (three piles per day, 3,000 strikes per pile for all project piles), installed by one pile driving crew during a single 10- or 12-hour workday, with no attenuation included for use of a bubble curtain. The result is an area of injury that would result in barotrauma of 59 m (193 ft) from pile-driving operations, and a potential area of injury that would result in auditory impairment of 148 m (485 ft) from pile-driving operations.

However, the majority of piles that will be impact driven will require only as many as 300 strikes per pile. If the 25 piles for the trestle that require up to 3,000 strikes per pile are separated from the rest of the project, the remaining 73 piles produce an area of injury that would result in barotrauma of 13 m (42 ft) from pile-driving operations, and a potential area of injury that would result in auditory impairment of 32 m (104 ft) from pile-driving operations.

Elevated in-water sound pressure exceeding ambient levels could result in disturbance/behavioral effects to marbled murrelet within 10,000 m (6.21 miles) of the project footprint. These elevated SPLs at the level of disturbance or injury will be temporary and intermittent, corresponding to approximately 45 minutes to 5.25 hours per work day of actual impact pile driving, for a maximum of 34 days during the in-water work window.

The underwater sound levels associated with this project are expected to exceed 202 dB cumulative SEL during impact pile driving. The SEL that will result from impact pile driving for the proposed projects, accumulated over all pile strikes, will exceed 202 dB (re: 1 μPa^2-sec). The number of pile strikes is estimated per continuous work period. This approach assumes that there will be a break of at least 12 hours between work periods. A break of this duration is typical for most pile-driving operations, and will provide a period for marbled murrelets to recover from exposure to elevated SPLs that could cause threshold shift or impacts to hearing due to hair cell damage.

To determine the cumulative probability of exposing one or more marbled murrelets to injurious sound levels from impact pile driving, we used the worst-case scenario of 3,000 strikes per pile for all project piles. The area of potential auditory injury within a radius of 148 m (area exceeding the 202 dB_{SEL}) from piling installation was subsequently combined with seasonal density statistics from 2011 through 2015, an assumed effectiveness percentage for marbled murrelet monitoring (78 percent), the number of piles driven within the summer season (April to September) and the winter season (October to March), and the land mass within the area of effect (0.0333 km^2 or 8.2 acres). Using these values, we determined that there is a 0.71 probability (U95 0.83) that at least one marbled murrelet will be exposed to injurious sound levels associated with impact pile driving during project construction. Because the cumulative probability of encountering one or more marbled murrelets (likelihood of exposure) within the area of potential injury exceeds what the Service considers to be an acceptable level of risk, we have determined that there is potential for injury and/or harassment to marbled murrelets. Marbled murrelets that are present within 148 m of impact pile driving of steel piles may be exposed to short-term injurious levels of sound for approximately 45 minutes to 5.25 hours per work day for a maximum of 34 days during the in-water work window (August 1, 2017, through February 15, 2018). These underwater SPLs are expected to cause injury, death, and/or significant disturbance to marbled murrelets if they are exposed to it.

The assumption of 3,000 strikes per pile for all impact pile driving represents a very conservative assessment of project impacts because the majority of piles that will be installed will require only 300 strikes per pile. Analyzed alone, the cumulative probability of exposing one or more marbled murrelets to injurious sound levels from impact pile driving associated with the 25 trestle piles is lower than the very conservative estimate for the project as a whole, but still exceeds the range of what the Service considers to be an acceptable level of risk. Impact pile driving for the trestle includes 3,000 strikes per pile for 6 piles installed within the summer

season (April to September) and 19 piles installed the winter season (October to March), and produces an area of potential auditory injury within a radius of 148 m (area exceeding the 202 dB_{SEL}). Marbled murrelets that are present within 148 m of impact pile driving of steel trestle piles may be exposed to short-term injurious levels of sound for approximately 5.25 hours per work day for a maximum of 9 days during the in-water work window (August 1, 2017, through February 15, 2018), but likely limited to a timeframe of September through October 2017.

In summary, the cumulative probability of encountering a marbled murrelet is above the threshold the Service has used to determine whether exposure is reasonably certain to occur, and we expect that exposure to these stressors will result in potential injury and/or harassment. If marbled murrelets are present and exposed within the zone of injury, within 148 m (486 ft) from installation of steel trestle piles, the magnitude and duration of sound exposure could result in injury (i.e., ranging from temporary hearing loss, permanent hearing damage, barotrauma to death) and/or significant disturbance to marbled murrelets if they are exposed to it. Given the low to moderate densities of marbled murrelets detected in the area of Possession Sound during NWFP Effectiveness Monitoring and U.S. Navy monitoring studies, and the regular observations of marbled murrelets in the vicinity of the existing Mukilteo ferry terminal and the Mukilteo Lighthouse, we estimate one to three marbled murrelets, representing one foraging group, may be harassed, injured, or killed due to exposure to high underwater sound levels. Marbled murrelet monitoring will be conducted during all impact pile driving. Pile driving will cease if marbled murrelets are observed in the zone of injury and will not resume until the birds have left the area of their own volition. While monitoring for individuals will reduce the potential for exposure, it does not completely eliminate the risk.

If an adult marbled murrelet is killed during the period when it is incubating eggs or feeding nestlings, we expect that its death will result in the death or at least reduced survival probability of the egg or chick. If an adult marbled murrelet is injured or harassed in such a way as to reduce its foraging success, the effects to the adult may also lead to a reduction in feeding of the chick. However, annual marbled murrelet breeding rates in Washington are currently very low (13 to 20 percent; see Lorenz et al. 2017, p. 313). The majority of impact-driven piles for the trestle structure will be installed during the winter season, with fewer than 10 piles installed in August or September during the late breeding season. Given the low reproductive rate and time of year when most of the impact pile driving will occur (mostly outside of the breeding season), it is extremely unlikely that adults tending eggs or chicks will be injured or killed. Therefore, we do not expect indirect adverse effects to eggs or chicks.

Temporary 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 et al. (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 play 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 m (SAIC 2012, p. 16). Therefore, foraging pairs of marbled murrelets need to receive these vocalizations at a level where they can recognize the calls. In-air sound can 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 noise (Brumm 2004, p. 434). Vocalizing animals confront a wide variety of noise 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 noise and the signal. Masking of communication during foraging could occur if in-air sound levels from pile driving interferes with communication between foraging partners.

Whether masking results in a significant disruption of normal behaviors that creates a likelihood of injury to an individual depends on a number of factors, including, but not limited to 1) the duration of exposure, 2) the probability of two or more foraging partners experiencing masking, 3) the distance of marbled murrelets from the sound source, 4) whether or not the marbled murrelets will employ strategies to offset the interference of their communication, and 5) whether the exposure would ultimately lead to a reduction in foraging efficiency that resulted in a measurable effect.

For the proposed action, steel piles that will be installed with an impact hammer are considered to produce in-air masking effects. Based upon recent guidance (USFWS 2013), for most projects in Puget Sound, the area where marbled murrelets are potentially affected by masking during pile driving would extend up to 168 m (551 ft) from 36-inch-diameter piles and up to 42 m (138 ft) from 24-inch-diameter piles being proofed or driven using an impact hammer. For this project, given the range of pile sizes that will be impact driven (Table 7), it is assumed that masking will occur between 42 and 168 m from impact pile-driving activities for all in-water pile installation. These elevated sound levels will be temporary and intermittent, corresponding to approximately 45 minutes to 5.25 hours per work day when installing in-water steel piles with impact pile driving, for a maximum of 34 days during the in-water work window (August 1, 2017, through February 15, 2018).

In addition to the in-water pile driving, the retaining walls for the promenade will require impact pile driving of 112 steel H-piles in upland areas, including 26 H-piles within 2 to 3 ft (0.6 to 0.9 m) of the MHHW mark and 86 H-piles within 12 to 13 ft (3.7 to 4 m) of MHHW. These piles are located close enough to the water that in-air noise from impact pile driving could affect foraging marbled murrelets. The 12-inch-diameter steel H-piles are closest in size to the 24-inch-diameter steel piles; and therefore, potential masking effects would be most likely occur within 42 m (138 ft) of impact driving. These elevated sound levels will be temporary and

intermittent, corresponding to approximately 3.3 hours per work day when installing steel H-piles for the promenade with impact pile driving, for a maximum of 12 days between July 2018 and April 2019.

We estimate that a pair of marbled murrelets may be present and exposed to project-related in-air sound while foraging; and it is reasonable to assume that this will result in masking of their communication in situations where piles are installed using an impact driver. This pair is the same group that may be injured or killed due to exposure to high underwater sound levels. We assume that it is equally likely that marbled murrelets will be underwater or on the surface (50/50). High in-air sound levels generated by impact pile driving could intermittently mask vocalizations between marbled murrelets each day that pile driving is conducted.

Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action (USFWS and NMFS 1998). The indirect effects associated with stormwater are discussed above in the Insignificant and Discountable Effects sections of the document.

Effects of Interrelated and Interdependent Actions

Interrelated actions are defined as actions “that are part of a larger action and depend on the larger action for their justification”; interdependent actions are defined as actions “that have no independent utility apart from the action under consideration” (50 CFR section 402.02).

Refer to the 2013 Biological Opinion.

EFFECTS OF THE ACTION: Bull Trout

Refer to the 2013 Biological Opinion for a detailed assessment of all project effects to bull trout. Where the project description has substantively changed, additional analysis of effects is provided below.

Insignificant and Discountable Effects

<u>Overwater Cover/Shading</u>

The project will achieve a substantial net reduction of 128,612 ft^2 (approximately 3 acres) of overwater cover because of the removal of the Tank Farm pier, existing ferry terminal, and existing fishing pier (described above in the marbled murrelet section), which may result in beneficial effects to habitat at the action area scale. Barges and other vessels needed for construction will create temporary shading within the project footprint; however, due to the temporary nature of the effects associated with barges and other craft, no significant effects to nearshore bull trout habitat or forage fish habitat are anticipated, and as a result, these effects are considered insignificant to bull trout and bull trout critical habitat.

Impacts to Benthic Habitat

As described above in the marbled murrelet section, the project will result in a 1,034 ft^2 net permanent gain of benthic habitat due to pile removal, as well as removing a chronic source of PAHs and other chemicals. Although this net gain in benthic habitat is less than the area described in the 2013 Opinion, the project will result in slight improvements of available habitat and habitat quality within the action area. These changes are not expected to measurably affect bull trout, their prey base, or the key functions provided by bull trout critical habitat.

Stormwater

The project will provide enhanced treatment for all stormwater generated on site, including infiltrated stormwater, and will result in decreased annual loadings of most stormwater constituents discharged into Possession Sound compared to the 2013 Opinion. The 2017 stormwater treatment design represents a substantial improvement over the treatment proposed in the 2013 Opinion (up to 44 percent; Table 6). However, baseline conditions will be slightly worsened in the vicinity of the ferry terminal because of the creation of new PGIS and a new outfall, and the resultant increase in annual loadings of stormwater constituents discharged into Possession Sound in perpetuity.

With consideration for the low numbers of adult and subadult bull trout potentially foraging or migrating in the immediate vicinity of the new terminal location, the limited extent of affected habitat within the immediate vicinity of the points of discharge (dilution zone is assumed to be within 50 ft of the outfalls), and the frequency, duration, and intensity of potential exposures, we expect that stormwater discharges will have no measurable effect on bull trout individuals, or their prey base. Therefore, effects to bull trout and their habitat associated with impacts to water quality are considered insignificant.

Upland Construction

Upland construction of the Mukilteo Ferry Terminal and associated infrastructure was analyzed in the 2013 Opinion, and remains unchanged apart from the change in type and number of foundation piles for the terminal (discussed in adverse effects section below), changes to the stormwater design (addressed in the section above), the addition of the upland slope protection for the promenade, and the potential use of a coffer dam for construction of the new outfall.

The retaining walls for the promenade will require impact pile driving 112 steel H-piles in upland areas, including 26 H-piles within 2 to 3 ft (0.6 to 0.9 m) of MHHW and 86 H-piles within 12 to 13 ft (3.7 to 4 m) of MHHW. The coffer dam will require vibratory driving 45 sheet piles within approximately 1 to 2 ft (0.3 to 0.6 m) of MHHW. The same sheet piles will be removed with a vibratory hammer after outfall construction is complete. These piles are located close enough to the water that noise and vibration may be transmitted into waters or sediments.

Elevated sound levels will be temporary and intermittent, corresponding to approximately 3.3 hours per work day when installing steel H-piles for the promenade with impact pile driving, over a maximum of 12 days. For the coffer dam, elevated sound levels will correspond to approximately 1.5 hours per day for vibratory installation of sheet piles over a maximum of 15 days, and 1.5 hours per day for vibratory removal of sheet piles over a maximum of 8 days (between November 2018 and February 2019).

Noise and vibration resulting from the upland work may extend into the immediately adjacent waters or sediments at levels detectable by fish. However, we do not expect that temporary sound extending from sediments to the water column will reach levels likely to cause significant behavioral disruption or physical injury. Any related temporary effects to normal bull trout behaviors (feeding, moving, and sheltering) will not be measurable and are therefore considered insignificant. These temporary impacts will not affect the key functions provided by bull trout critical habitat, and are therefore considered insignificant.

A subset of the H-piles closest to MHHW (3 piles) will be included in the hydroacoustic monitoring plan, as described in the Conservation Measures and the Upland Retaining Wall sections of the Project Description, to determine if noise levels of concern are entering the water. If monitoring detects significant underwater noise levels from H-pile driving for the promenade, reinitiation of consultation will be required.

Adverse Effects of the Action

<u>Temporary Exposure to Elevated Turbidity</u>

We expect construction of the project includes activities that will temporarily degrade water quality and result in measureable adverse effects to bull trout and their habitat. Installation and removal of piles and installation of riprap will result in temporary impacts to water quality because of elevated turbidity levels. Based on the RBA, during vibratory and impact driving or removal, increased turbidity surrounding the piles will be confined to within 150 ft of the piles.

Pile removal is the project activity likely to create the greatest risk of exposure to elevated turbidity and contaminants. Vibratory removal of 168 temporary piles associated with construction of the proposed facility will occur for approximately 44.25 hours over 39 days during the approved in-water work window (August 1, 2017, through February 15, 2018, and November 2018 through February 15, 2019, for sheet piles associated with the coffer dam). For the existing terminal and fishing pier, pile removal activities will occur for 73 hours over a period of 2 weeks during the in-water work window (December 2019 to February 15, 2020), as described in the 2013 Opinion.

Pile installation may also result in exposure to elevated turbidity and contaminants, although to a lesser extent than pile removal, and has increased from the 288 piles and stone columns in the 2013 Opinion. Vibratory installation of 401 steel piles will occur for 1 to 5 hours per day over 104 days, and impact driving of 98 steel piles will occur for 45 minutes to 5.25 hours per day over 34 days, both during the approved in-water work window (August 1, 2017, through February 15, 2018, and November 2018 through February 15, 2019, for sheet piles associated with the coffer dam).

Additional riprap will be placed along a portion of the shoreline that is already armored over an area of approximately 1,700 ft^2 for the in-water slope protection from propeller wash at the new ferry dock. This work will occur over approximately 3 to 4 weeks. We assume that increased turbidity and/or resuspended contaminants surrounding the locations of riprap placement will be confined to within 150 ft of the riprap, similar to the estimates for pile removal and installation.

Adult and subadult bull trout may occupy the waters immediately surrounding the existing and proposed ferry terminal and public fishing pier at any time of year. Data to estimate the number of bull trout that may forage, migrate, and overwinter in this portion of the action area are limited; however, recent telemetry studies (Goetz et al. 2012) documented the presence of winter migrants in the vicinity of the project between November and January, and other data document bull trout presence in nearshore areas between April and August. As a result, given the size of the affected area and duration of anticipated in-water work (up to 219 days), the potential of bull trout presence during construction of in-water work project elements cannot be discounted, nor can the potential exposure of individual bull trout to project-related turbidity impacts. Pile removal, pile installation, and placement of riprap will produce conditions of high turbidity that are most intense closest to the operations. Direct exposure to suspended sediments in the water column would be limited to the time periods described above.

Temporary Exposure to Contaminants and Degraded Water Quality

The 2013 Opinion described sampling efforts throughout the action area in upland soils, groundwater, and nearshore sediments, which resulted in detection of petroleum hydrocarbons, benzene, toluene, ethylbenzene and xylenes. Accumulation of PAHs in sediment from creosote-treated piles is normally limited spatially (within approximately 30 ft of the structure) (Stratus 2006).

Direct exposure to contaminants in the water column from pile removal, pile installation, or riprap placement would be limited to the time periods and locations described above for turbidity (up to 219 days within 150 ft of activities for pile removal, pile installation, and placement of riprap). 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).

Given the presence of bull trout in the action area, the industrial history of the project site, and the physical and temporal extent of turbidity and sediment effects described above, bull trout in the action area could potentially be exposed to elevated levels of contaminants and/or contaminated sediments as a result of project activities. It is difficult to accurately predict the direct or indirect effects to individual bull trout resulting from short-term exposure to chemicals in the sediments because the toxic effects depend on several factors such as route of exposure and physical condition of the organism during exposure, duration of exposure, and concentrations of the chemicals in the water column.

The areas defined above represent the extent of short-term contaminant exposure resulting from project activities. Due to the rapid rate of observed bull trout migration and movement within the marine environment in the vicinity, we anticipate exposure events would be brief (less than 1 hour), and are not expected to result in injury.

Temporary exposures to contaminants could potentially disrupt normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter). Project-related impacts to water quality may cause bull trout to temporarily avoid the area, may impede or discourage free movement through the area, and may prevent individuals from exploiting preferred habitats. Elevated contaminant concentrations may also expose individuals to less favorable conditions (contaminated food-chain). Given the limited number of bull trout observed in the project vicinity, the limited prey resources, and the rapid documented movement of migrating bull trout, direct and indirect exposures potentially resulting in behavioral effects would be limited to a small number of individual fish.

Temporary Exposure to Elevated Underwater Sound

As described above in the marbled murrelet section, both vibratory and impact pile driving produce elevated underwater SPLs that can affect fish; however, only impact pile-driving noise has the potential to have injurious effects on fish.

As of June 2008, the Service, the Federal Highway Administration (FHWA), WSDOT, and other signatory agencies have endorsed application of criteria for estimating onset of injury developed by the Fisheries Hydroacoustic Working Group (FHWG 2008). These criteria apply a SEL framework for assessing injury to fish. The criteria for fish injury identify a single-strike SPL of 206 dBpeak re: 1 µPa and 183 dB accumulated SEL re: 1 µPa2s for fish smaller than 2 grams and a single-strike SPL of 206 dBpeak and 187 dB accumulated SEL re: 1 µPa2s for fish larger than 2 grams (FHWG 2008).

As described above in the marbled murrelet section, we use the practical spreading model to determine the distance at which transmission loss attenuates sound to levels below thresholds for injury and significant behavioral interference. We use the estimated pile driving noise levels provided by WSF (a single-strike SPL of 206 dBpeak re: 1 µPa and 195 dB_{RMS} re: 1 µPa, a single-strike SEL of 180 dB re: 1 $\mu Pa^2 s$), and assumed as many as 9,000 strikes per day (three piles per day, 3,000 strikes per pile for all project piles), installed by one pile driving crew during a single 10- or 12-hour workday, with no attenuation included for use of a bubble curtain. The result is a worst-case scenario area of injury of 1,000 m (0.62 mile) from pile-driving operations for bull trout (both less than and greater than 2 grams) and 10,000 m (6.21 miles) from pile-driving operations for potential behavioral effects to bull trout. These short-term injurious levels of sound are expected to occur for approximately 45 minutes to 5.25 hours per work day for a maximum of 34 days during the in-water work window (August 1, 2017, through February 15, 2018).

However, the majority of piles that will be impact driven will require only as many as 300 strikes per pile, as described above in the marbled murrelet section. If the 25 piles for the trestle that require up to 3,000 strikes per pile are separated from the rest of the project, the remaining 73 piles produce an area of injury of 318 m (0.20 mile) from pile-driving operations for bull trout

greater than 2 grams. The area of injury will therefore be much smaller than the worst-case scenario during the majority of pile driving operations, corresponding to approximately 45 minutes per work day for a maximum of 25 days during the in-water work window (August 1, 2017, through February 15, 2018). The area of injury for the 25 trestle piles would be the same as the area described for the project as a whole, but would be for a much shorter duration: approximately 5.25 hours per work day for a maximum of 9 days during the in-water work window (August 1, 2017, through February 15, 2018), but likely limited to a timeframe of September through October, 2017.

We expect that subadult and adult bull trout exposed to an accumulated SEL of 187 dB re: 1 $\mu Pa^2 s$ will be injured or killed. We also expect that subadult and adult bull trout, when exposed to single-strike SPLs of 150 dB_{RMS} re: 1 µPa or above, will experience a significant disruption of their normal behaviors (i.e., ability to successfully feed, move, and/or shelter). Pile driving with an impact hammer may cause bull trout to temporarily avoid the area, impede or discourage free movement through the area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions.

Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action (USFWS and NMFS 1998). The indirect effects associated with stormwater are discussed above in the Insignificant and Discountable Effects sections of the document.

Effects of Interrelated and Interdependent Actions (Bull Trout and Critical Habitat)

Interrelated actions are defined as actions “that are part of a larger action and depend on the larger action for their justification”; interdependent actions are defined as actions “that have no independent utility apart from the action under consideration” (50 CFR section 402.02).

Refer to the 2013 Biological Opinion.

Effects of the Action: Bull Trout Critical Habitat

Construction activities conducted below MHHW will produce stressors with potential temporary adverse effects to bull trout critical habitat. These stressors include temporary adverse effects to water quality (turbidity, low-level contamination, increased metals loading or concentrations) resulting from pile removal and installation activities, placement of riprap, sediment transport, and stormwater releases. As discussed above, these exposures may temporarily cause bull trout to avoid the these areas, may impede or discourage free movement through the action area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions. As a result, foraging, migration and overwintering functions provided by the designated critical habitat in the project area could be temporarily degraded, inhibited, or obstructed as a result of these stressors.

Suitable bull trout rearing and spawning habitats are not present in the action area; and therefore the project will have no effect on bull trout rearing or spawning habitat, or these essential behaviors. A discussion of how each PCE is affected by project activities is provided below.

PCE 1: Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

The project will have no measurable effects to short or long term function of this PCE. Within the action area this PCE will retain its current level of function.

PCE 2: Migratory habitat with minimal physical, biological, or water quality impediments.

The project will result in temporary and permanent adverse effects to this PCE. Construction activities will temporarily impair the function of the migratory corridor surrounding the project (impact pile driving below the MHHW; pile removal and installation; riprap placement), intermittently over 219 days during the in-water work window (August 1, 2017, through February 15, 2018, and November 2018 through February 15, 2019, for sheet piles associated with the coffer dam). Removal and installation of structures in the nearshore (terminal, trestle, wingwalls, dolphins, and fishing pier) will shift and introduce new physical impediments (overwater cover and wing walls) within the nearshore environment in perpetuity. However, in the long term, despite these new structures, the project as a whole will result in a net reduction of overwater structures in the nearshore environment. The large Tank Farm Pier, which was a 128,612 ft^2 (approximately 3 acres) derelict structure supported on creosote-treated pilings, has already been removed. Periodic releases of stormwater constituents into the nearshore environment from pollution-generating impervious surface will continue in perpetuity. The effects of these constituents to water quality and nearshore habitat (via metals concentrations and loading) in the marine environment are expected to be confined to the immediate vicinity (50 ft) of the outfalls, and will not measurably degrade or diminish the key functions provided by bull trout migratory habitat at the action area or larger scales. All other project elements and activities will result in no measurable effects to short or long term function of this PCE. We expect that the project will maintain the current level of function for this PCE.

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

There is no large overhanging woody vegetation within the project footprint. The existing conditions within the defined area of critical habitat consist of mostly large and small cobble to the west of the proposed new ferry terminal, large and small cobble inshore of the MLLW line, and sand/mud with some wood debris to the east of the proposed ferry terminal (MRC 2000). The shoreline where the new ferry terminal will be built is heavily armored with riprap, and seawalls are adjacent to the proposed ferry terminal. Macroalgae occurs in the vicinity, but eelgrass (*Zostera* sp.) is sparse to absent.

The project will result in temporary and permanent adverse effects in addition to beneficial permanent effects to this PCE. We expect a decrease in forage fish and water quality due to impacts from pile removal, pile installation, and riprap installation; but impacts will be temporary; anticipated adverse effects would be limited to within a 150-foot radius of these activities. Features included in the project (i.e., temporary piling, barges) will result in temporary adverse effects to native substrate and associated epibenthic and infaunal communities. Permanent adverse effects will result from features of the project including permanent piling and overwater cover (2,281 ft^2 of benthic impacts, 21,626 ft^2 of overwater

cover, and distribution of potentially contaminated sediments within 150 ft of pile installation and removal activities), and will persist indefinitely or for the functional life of the constructed features. However, compared to the current area of benthic impacts and overwater coverage, the project will result in a significant reductions in overwater cover (128,612 ft^2) and a net gain of potential benthic habitat (1,034 ft^2) resulting in long-term improvements to habitat conditions. The degree to which redistribution of contaminated sediments could affect benthic organisms or result in food chain bioaccumulation cannot be accurately predicted. Removal of the existing ferry terminal, which is currently located adjacent to suitable forage fish spawning habitat, will provide additional spawning habitat for sand lance and potentially other forage fish species. All other project elements and activities will result in no measurable effects to short or long term function of this PCE. Given the nature, size, and duration of these effects, we expect that within the action area this PCE will retain its current level of function.

PCE 5: Water temperatures ranging between 2 to 15°C (36 to 59°F), with adequate thermal refugia available for temperatures at the upper end of the range.

The project will have no measurable effects to short or long term function of this PCE. Within the action area this PCE will retain its current level of function.

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

The marine waters of Possession Sound near the ferry terminal are designated “Extraordinary” for aquatic life use per WAC 173-201(a). The project will result in temporary and permanent (stormwater) adverse effects to this PCE. Construction activities will impair water quality (pile installation and removal, riprap installation), intermittently over approximately 219 days during the in-water work window (August 1, 2017, through February 15, 2018, and November 2018 through February 15, 2019, for sheet piles associated with the coffer dam). Stormwater releases will affect water and habitat quality up to 50 ft from each of the outfalls in perpetuity. All other project elements and activities will result in no measurable effects to short- or long-term function of this PCE. We expect that the project will have no measurable, permanent effects to this PCE, and within the action area this PCE will retain its current level of function.

In summary, we expect that the action will result in adverse effects to critical habitat resulting from temporary and permanent adverse effects to PCE #2 (migration habitats with minimal impediments), PCE #3 (food base), and PCE #8 (water quantity and quality), but that the extent of these impacts will not destroy or adversely modify bull trout critical habitat. The critical habitat rangewide would remain functional (or would retain the current ability for the PCEs to become functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the bull trout.

CUMULATIVE EFFECTS: Marbled Murrelet, Bull Trout, and Designated Bull Trout Critical Habitat

Cumulative effects include the effects of future state, tribal, local, or private actions 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 Act.

A summary of projects that are reasonable certain to occur in the action area is provided in Table 8.

Table 8. Non-federal projects in the action area

Project	Project Proponent	Description	Potential Cumulative Effects
Redevelopment of holding areas at existing terminal	TBD-Private entities	The area currently occupied by ferry holding lanes would be redeveloped. Redevelopment would likely be a mix of commercial and residential units.	The holding lanes do not provide habitat for any listed species. Future development could result in potential reduction in PGIS or improvements in stormwater runoff treatment.[1]
Mount Baker Crossing	Port of Everett	This project would create an improved at-grade crossing of the BNSF railroad track connecting Mukilteo Lane to the Tank Farm.	None: The project area does not provide habitat for any listed species.
City of Mukilteo Lighthouse Park Improvements Project	City of Mukilteo	Phase 3 of this project includes improvements to Front Street, completion of the park driveway and construction of the parking area in the southeast corner of the site.	This project would create additional PGIS, potentially increasing pollutant loading to Possession Sound. Impacts would be offset or minimized by designing the project according to appropriate city and county stormwater codes.
Lift Station #10 Replacement Project	Mukilteo Water and Wastewater District	This project would replace the existing Lift Station #10 with a new 1,500 ft^2 lift station built on an undeveloped parcel. Construction includes associated grading, landscaping, and street frontage improvements.	This project would create additional PGIS, potentially increasing pollutant loading to Possession Sound. Impacts would be offset or minimized by designing the project according to appropriate city and county stormwater codes.

1 See 2013 Biological Opinion for further description of potential cumulative effects.

The projects above that will increase existing PGIS have the potential to further degrade the existing environmental baseline via additional stormwater runoff and resultant increases in loading and possibly stormwater constituent concentrations to Possession Sound. If these projects result in additional in-water structures or overwater cover, they could also further degrade baseline aquatic habitat conditions or habitat suitability or availability in the action area.

If these projects are limited to upland areas and reduce PGIS or result in improved stormwater runoff treatment, they could help to maintain or even slightly improve the existing baseline conditions in the action area or Possession Sound. Upland habitat impacts associated with these projects will have insignificant impacts on listed species due to the limited suitability of habitats in the action area.

We expect the actions described above will result in insignificant effects to marbled murrelet individuals and that these effects will not translate to measurable effects to the Conservation Zone 1, Stratum 3 population.

We expect these same activities, with the exception of any project reducing PGIS or improving stormwater runoff treatment, will result in adverse effects to individual bull trout by perpetuating degraded baseline conditions within the action area, by potentially exposing bull trout to additional stormwater runoff and loading or elevated concentrations of stormwater constituents. We do not expect that these effects to individual bull trout will translate to measurable adverse effects to core areas or associated bull trout populations. Likewise, these activities will result in adverse effects to critical habitat resulting from temporary effects to PCEs #2 (migration habitats with minimal impediments) and #8 (water quantity and quality), but that the extent of these impacts will not destroy or adversely modify bull trout critical habitat. The critical habitat rangewide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the bull trout.

INTEGRATION AND SYNTHESIS OF EFFECTS: Marbled Murrelet

After reviewing the population status of marbled murrelets in Conservation Zone 1 Stratum 3, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's Biological Opinion that this project, as proposed, is not likely to jeopardize the continued existence of marbled murrelets, as summarized below.

The action area provides suitable marine habitat for the marbled murrelet and is known to support low to moderate numbers during both the summer and winter months. Based upon location and baseline environmental conditions, we expect that marbled murrelets use the nearshore waters near Mukilteo and may be present in low to moderate numbers during construction and operation of the new ferry terminal.

In-water and in-air sound levels above ambient produced from vibratory pile driving and removal at the existing and new terminal locations and associated facilities are not expected to result in any significant behavioral effects to marbled murrelets. However, impact pile-driving activities included in this project may result in death, injury, or harassment of marbled murrelets. The project will generate periods of elevated underwater sound levels sufficiently high to cause injury of a pair of marbled murrelets (representing one foraging group) and short-term disruption of normal behavior patterns. The zone of potential injury (underwater) extends approximately 148 m from impact pile-driving operations. The elevated underwater sound at the level of disturbance or injury will be temporary and intermittent, corresponding to approximately

5.25 hours per work day when installing steel trestle piles with impact pile driving, over a time period of 9 days between September 1 and October 31, 2017, as summarized in the Effects of the Action section and in Table 7.

The project will also result in periods of elevated in-air sound, which could lead to masking of communication between marbled murrelets in this same foraging group (pair). The zone of potential masking extends between 42 m and 168 m from in-water impact pile-driving operations and for upland pile driving occurring adjacent to the water. The elevated in-air sound levels that could cause masking of vocalizations will be temporary and intermittent, corresponding to approximately 45 minutes to 5.25 hours per work day when installing steel piles with impact pile driving, over a time period of 34 days for in-water pile driving between August 1, 2017, and February 15, 2018, and an additional 12 days for upland pile driving between July 2018 and April 2019, as summarized in the Effects of the Action section and in Table 7.

In summary, we anticipate there will be measurable effects to one foraging group of marbled murrelets (two individuals or a pair).

Given the relatively small area of marine habitat exposed to disturbance stressors, the low to moderate density of marbled murrelet in the action area, and the fact that monitoring will be conducted during all impact pile driving activities, we expect few marbled murrelets to be adversely affected by the action. The low numbers of marbled murrelets potentially exposed to injurious levels of underwater sound are not anticipated to appreciably reduce the likelihood of survival and recovery of the species. Because there would be no measurable reductions in juvenile recruitment, overall numbers of marbled murrelets, or productivity at the scale of the action area or Conservation Zone, we do not expect the effects of the project to contribute to the present rates of observed population declines at the Conservation Zone and range-wide scales.

INTEGRATION AND SYNTHESIS OF EFFECTS: Bull Trout and Designated Bull Trout Critical Habitat

After reviewing the population status of bull trout and the environmental baseline for bull trout critical habitat in the action area, the effects of the proposed action and the cumulative effects, it is the Service's Biological Opinion that this project, as proposed, is not likely to jeopardize the continued existence of bull trout or adversely affect bull trout critical habitat, as summarized below.

Based on location, extent of impacts and proximity to bull trout core areas and local populations, it is reasonable to conclude that a few individuals will be exposed to the action’s short- or long-term effects. However, we are unable to quantify a specific number of individuals with any accuracy. Instead, we use a habitat surrogate to describe the extent of project related effects to bull trout and bull trout critical habitat. Suitable bull trout rearing and spawning habitats are not present in the action area, and therefore the project will have no effect on eggs or juvenile bull trout rearing or spawning habitat, or these essential behaviors.

We estimate that any bull trout that is within 318 m of impact pile driving operations may be injured or killed during the installation of the 73 non-trestle piles, for 45 minutes per day over a period of 25 days. Similarly, any bull trout that is within 1,000 m of impact installation of the

25 trestle piles may be injured or killed; the duration of exposure for the trestle piles is 5.25 hours per day over a period of 9 days. These subadult and adult bull trout are most likely individuals from the Skagit, Stillaguamish, or Snohomish/Skykomish bull trout core areas. Given the small number of bull trout affected, we expect that no measurable effect to numbers (abundance) will be evident at the scale of any local population or core area.

The project involves replacing the existing terminal, ferry dock, and public fishing pier at Mukilteo with similar new structures approximately 0.36 mile to the northeast and removing the Tank Farm pier (already completed). We expect that the number of bull trout that will experience a significant impairment of their normal behavior (e.g., avoiding preferred habitats, delayed movement) will be very low (i.e., a few individuals at most). Measurable effects to marine foraging, migration, or overwintering habitat (or migrating or foraging individuals) will be temporary, and we expect that no measurable short- or long-term effects to the distribution will be evident at the scale of the local populations or core areas.

The action will result in adverse effects to critical habitat associated with temporary and permanent adverse effects to PCE #2 (migration habitats with minimal impediments), PCE #3 (food base), and PCE #8 (water quantity and quality). Given the nature, size, and duration of these effects, we expect that critical habitat in the action area, the critical habitat unit, and rangewide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of degraded but sporadically occupied habitat) to serve its intended recovery role for the bull trout.

CONCLUSION

After reviewing the current status of the marbled murrelet and bull trout, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is Service's Opinion that the action, as proposed, is not likely to jeopardize the continued existence of marbled murrelets or bull trout, and is not likely to destroy or adversely modify designated critical habitat for bull trout

Critical habitat for marbled murrelet has been designated at many locations around western Washington. However, the closest critical habitat is approximately 32 km (20 miles) from the project footprint, and this action does not affect that area. No destruction or adverse modification of that critical habitat is anticipated.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act 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 Service as an act that 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 Service as an intentional or negligent act or omission that 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 Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The Service is to be notified within 3 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.

The measures described below are non-discretionary, and must be undertaken by the (agency) so that they become binding conditions of any grant or permit issued to the (applicant), as appropriate, for the exemption in section 7(o)(2) to apply. The FHWA and Federal Transit Administration (FTA) have a continuing duty to regulate the activity covered by this Incidental Take Statement. If the FHWA and FTA 1) fail to assume and implement the terms and conditions or 2) fail to require the (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 FHWA and FTA must report the progress of the action and its impact on the species to the Service as specified in this Incidental Take Statement [50 CFR 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE: Marbled Murrelet

The Service anticipates that take in the form of harm (auditory injury) and harass (masking) to foraging marbled murrelets within Conservation Zone 1, Stratum 3 will result from the project.

1. Incidental take of one foraging group of marbled murrelets (two individuals or a pair) in the form of harm as a direct effect of exposure to elevated underwater sound pressure levels resulting from impact pile driving and proofing.

    a. Take will persist within 148 m of the trestle for 9 days during the installation of 25 trestle piles within the in-water work window (August 1, 2017, through February 15, 2018).

2. Incidental take of the same marbled murrelets or foraging group in the form of harassment from exposure to elevated in-air sound levels during impact pile driving that would result in a significant disruption of normal behavior (masking of marbled murrelet communication).

    a. Take will persist between 42 to 168 m of the trestle and other in-water piling structures for 34 days during the installation of 98 piles for in-water project elements and for 12 days during installation of the 112 H-piles for the promenade upland retaining wall within the in-water work window (August 1, 2017, through February 15, 2018).

EFFECT OF THE TAKE

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat when the reasonable and prudent alternative is implemented.

REASONABLE AND PRUDENT MEASURES

The project incorporates design elements and conservation measures that we expect will reduce permanent effects to habitat and avoid and minimize impacts during construction. We expect that the FTA and WSF will fully implement these measures, and therefore they have not been specifically identified as Reasonable and Prudent Measures (RPM) or Terms and Conditions.

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize the impacts (i.e., the amount or extent) of incidental take of marbled murrelet:

1. Minimize and monitor incidental take of marbled murrelet caused by elevated sound pressure levels from impact driving and proofing of steel piles.

The conservation measures negotiated in cooperation with the Service and included as part of the proposed action (see page 8 of this document) constitute all of the reasonable measures necessary to minimize the impacts of incidental take. On that basis, no RPMs except for monitoring and reporting requirements are included in this Incidental Take Statement.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the FHWA and FTA 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.

1. The FHWA, FTA, and WSF will submit a marbled murrelet monitoring report to the Service's Washington Fish and Wildlife Office in Lacey, Washington, by April 1 following each construction season. The report shall include, at a minimum, the

following: (a) observation dates, times, and conditions, (b) description of any "take" identified by the biologist, (c) copies of field data sheets or logs, and (d) duration and frequency of shut downs of pile driving due to presence of marbled murrelets and/or when sea state conditions exceed a Beaufort Sea State 2 in the monitoring area.

2. The FHWA, FTA, and WSF shall not exceed the 202 dB SEL re: 1 $\mu Pa^2 s$ injury threshold for marbled murrelet at a distance of more than 148 m (485 ft) from pile-driving activities. Adequate attenuation will be achieved to ensure these SPLs at these distances are not exceeded by using a noise attenuation device (e.g., bubble curtain or other device that achieves that objective), as described in the 2013 Biological Opinion and incorporated here by reference.

3. Contact the Service within 24 hours if hydroacoustic monitoring indicates that SPLs will exceed the extent of take exempted in the Opinion. The FHWA and FTA shall consult with the Service regarding modifications to the proposed action in an effort to reduce SPLs below the limits of take and continue hydroacoustic monitoring.

4. The FHWA, FTA, and WSF will submit a hydroacoustic monitoring report to the Service's Washington Fish and Wildlife Office in Lacey, Washington, by April 1 following each construction season. The report shall include, at a minimum, the following: (a) size and type of piles driven and proofed, (b) detailed description of the noise attenuation device, if used, (c) the impact hammer force used to drive and proof piles, (d) description of monitoring equipment, (e) distance between hydrophone and pile, (f) depth of the hydrophone, (g) distance from the pile to the wetted perimeter, (h) the depth of water, (i) depth into the substrate the pile was driven and proofed, and (j) the results of the hydroacoustic monitoring including the frequency spectrum, SPLs, and single strike and cumulative SELs. The report must include the ranges and means for peak, RMS, and SELs for each pile.

The Service believes that no more than two marbled murrelet will be incidentally taken as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

The Service is to be notified within 3 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.

AMOUNT OR EXTENT OF TAKE: Bull Trout

The Service anticipates that take in the form of harm and harassment of adult and subadult bull trout from the Skagit, Stillaguamish, and Snohomish/Skykomish core areas will result from the project.

The Service expects that incidental take of bull trout will be difficult to detect or quantify for the following reasons: 1) the low likelihood of finding dead or injured individual; 2) delayed mortality, and 3) losses may be masked by seasonal fluctuations in numbers. Where this is the case, we use a description of the affected habitat (i.e., physical extent, frequency and duration) and the intensity of temporary exposures as a surrogate indicator of take.

1. Incidental take of bull trout in the form of harassment from exposure to elevated turbidity, sedimentation, and associated elevated contaminant concentrations from pile removal, pile installation, and riprap placement activities, resulting in temporary avoidance of preferred habitats and/or delayed movement through the project area during construction.

    a. Take will persist for up to 39 days within 150 ft of vibratory removal of 168 temporary piles during the in-water work window (August 1, 2017, through February 15, 2018, and November 2018 through February 15, 2019, for sheet piles associated with the coffer dam).

    b. Take will persist for up to 14 days within 150 ft of vibratory removal of piles associated with the existing ferry terminal during the in-water work window (December 2019 through February 15, 2020).

    c. Take will persist for up to 104 days within 150 ft of vibratory installation of 401 piles and up to 34 days for impact driving of 98 piles during the in-water work window (August 1, 2017, through February 15, 2018, and November 2018 through February 15, 2019, for sheet piles associated with the coffer dam).

    d. Take will persist for approximately 30 days within 150 ft of the riprap installation area (1,700 ft^2) during the in-water work window (August 1, 2017, through February 15, 2018).

2. Incidental take of bull trout in the form of harm from exposure to elevated underwater sound pressure levels resulting from impact pile driving and proofing.

    a. Take will occur within 318 m (0.20 mile) of impact pile driving operations and will persist for 25 days during the installation of 73 non-trestle piles within the in-water work window (August 1, 2017, through February 15, 2018).

b. Take will occur within 1,000 m (0.62 mile) of impact pile driving operations for all bull trout, and will persist for 9 days during the installation of 25 trestle piles within the in-water work window (August 1, 2017, through February 15, 2018).

EFFECT OF THE TAKE

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat when the reasonable and prudent measures are implemented.

REASONABLE AND PRUDENT MEASURES

The project incorporates design elements and conservation measures that we expect will reduce permanent effects to habitat and avoid and minimize impacts during construction. We expect that the FTA and WSF will fully implement these measures, and therefore they have not been specifically identified as Reasonable and Prudent Measures (RPM) or Terms and Conditions.

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize the impacts (i.e., the amount or extent) of incidental take of bull trout:

1. Minimize and monitor incidental take caused by elevated turbidity, contaminants, and impaired water quality due to increased sedimentation during construction.

2. Minimize and monitor incidental take caused by elevated underwater sound pressure levels during construction.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the FHWA and FTA 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 RPM 1:

1. The FTA and WSF will submit a monitoring report to the Washington Fish and Wildlife Office in Lacey, Washington by April 1 following the construction season. The report shall include, at a minimum, the following: (a) dates, times and locations of construction activities, (b) monitoring results, sample times, locations and measured turbidities (in NTUs), (c) summary of construction activities and measured turbidities associated with those activities, and (d) summary of corrective actions taken to reduce turbidity.

2. The FTA and WSF shall document all waste handling, containment, testing, storage, treatment, and disposal operations according to all applicable state and federal requirements. The FTA shall submit a monitoring report to the Washington Fish and

Wildlife Office in Lacey, Washington (Attention: Consultation Partnership Branch), by April 1 following the construction season. The report shall include, at a minimum, the following: (a) a description of the treatment facilities and/or BMPs utilized on site, (b) a quantitative waste characterization or profile for any sediments and water disposed at an in-water dredged material disposal site, and (c) a summary of corrective actions taken to minimize or contain the spread of contaminants.

The following terms and conditions are required for the implementation of RPM 2:

1. The FTA and WSF will submit a monitoring report to the Washington Fish and Wildlife Office in Lacey, Washington, by April 1 following the construction season. The report shall include, at a minimum, the following: (a) dates, times and locations of construction activities, (b) monitoring results, sample times, locations and analytical results, (c) summary of construction activities and measured sound pressure levels associated with those activities, and (d) summary of corrective actions taken to reduce underwater sound pressure levels.

2. The FHWA, FTA, and WSF shall not exceed the 187 dB SEL (fish larger than 2 grams) injury thresholds for bull trout at a distance of more than 1,000 m (0.62 mile) from pile-driving activities. Adequate attenuation will be achieved to ensure these SPLs at these distances are not exceeded by using a noise attenuation device (e.g., bubble curtain or other device that achieves that objective), as described in the 2013 Biological Opinion and incorporated here by reference.

3. Contact the Service within 24 hours if hydroacoustic monitoring indicates that SPLs will exceed the extent of take exempted in the Opinion. The FHWA and FTA shall consult with the Service regarding modifications to the proposed action in an effort to reduce SPLs below the limits of take and continue hydroacoustic monitoring.

4. The FHWA, FTA, and WSF will submit a hydroacoustic monitoring report to the Service's Washington Fish and Wildlife Office in Lacey, Washington, by April 1 following each construction season. The report shall include, at a minimum, the following: (a) size and type of piles driven and proofed, (b) detailed description of the noise attenuation device, if used, (c) the impact hammer force used to drive and proof piles, (d) description of monitoring equipment, (e) distance between hydrophone and pile, (f) depth of the hydrophone, (g) distance from the pile to the wetted perimeter, (h) the depth of water, (i) depth into the substrate the pile was driven and proofed, and (j) the results of the hydroacoustic monitoring including the frequency spectrum, SPLs, and single strike and cumulative SELs. The report must include the ranges and means for peak, RMS, and SELs for each pile.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the project. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

The Service is to be notified within 3 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.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act 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.

The USFWS also requests the FTA and WSF implement the programmatic approach to monitoring stormwater detailed in the "Programmatic Monitoring Approach for Highway Stormwater Runoff in Support of Endangered Species Act Section 7 Consultations." The sites selected for this programmatic monitoring approach should be representative of conditions within the action area, including average daily traffic and seasonal and temporal variations in stormwater runoff quantity and quality. If the programmatic monitoring shows that the analysis underestimated the effluent concentrations or the size of the dilutions zones, then the reinitiation of consultation may be necessary.

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

REINITIATION NOTICE

This concludes formal consultation on the action(s) outlined in the request for formal consultation. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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APPENDIX A: MARBLED MURRELET MONITORING PLAN

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U.S. Fish and Wildlife Service – Washington Fish and Wildlife Office
Protocol for Marbled Murrelet Monitoring During Pile Driving (Revised 10/30/2013)

1.0 Objective

The intent of the monitoring protocol is to:

1. Comply with the requirements of the Endangered Species Act Section 7 consultation.
2. Detect all marbled murrelets (*Brachyramphus marmoratus*) (murrelets) within the monitoring area.
3. To minimize take of murrelets from both exposure to potentially injurious underwater sound pressure levels, and from the masking effects of in-air sound by communicating immediately with the pile driver operator.
4. Track incidental take exempted through the Incidental Take Statement found in the final Biological Opinion for the project so that the Lead Federal Action Agency will know when take occurs and/or when take exemptions might be exceeded.

2.0 Adaptive Approach

The individuals that implement this protocol will assess its effectiveness during implementation. They will use their best professional judgment throughout implementation and will seek improvements to these methods when deemed appropriate. Any modifications to this protocol will be coordinated between the Lead Federal Action Agency and the Washington Fish and Wildlife Office.

3.0 Monitoring

3.1 Activities to be Monitored

Application of this protocol is required as specified through the Endangered Species Act consultation process for individual projects. It may apply to projects that involve either in-water impact pile driving when injurious sound pressure levels are expected and to projects that involve either vibratory or impact pile driving when in-air sounds are expected to cause masking effects.

3.2 Equipment

- Binoculars - quality 8 or 10 power
- Spotting scopes (optional)
- Two-way radios with earpieces
- Range finder
- Log books

- Seabird identification guide
- Life vest or other personal flotation device for observers in boats
- Cellular phone to contact Lead Federal Action Agency, the Construction Contractor, or WFWO.

3.3 Monitoring Locations

The spacing and placement of monitoring locations must be designed to provide adequate coverage of the entire monitoring area. Locations are determined ahead of time and are identified on the Seabird Monitoring Site/Transect Identification Form. The monitoring design should allow for the entire monitoring area to be fully surveyed within five minutes.

Each land-based observer can cover a 180º arc over a 50 meter (m) area. Each boat observer can cover a 50 m transect on one side of the boat. Using the *Seabird Monitoring Site/Transects Identification Form*, insert an aerial photo of the project site and outline each boat transect or land-based monitoring site. Identify on the aerial photo where each of the two types of monitoring (boat transects and land-based sites) will occur (See Example Dolphin Repair). Construction activity and/or other site specific variables (i.e., topography, pier or barge placement, etc.) can limit visibility. These should be identified on the aerial photo when known ahead of time. If conditions change on-site (e.g., a barge moves into the monitoring zone), monitoring locations can be refined in the field. In that case, note final monitoring locations on an aerial photo or plan sheet, and document the changes in the final monitoring report.

For each land-based monitoring site, draw the shoreline on the *Seabird Land-Based Monitoring Site Form*. Include on-site information such as structures that could be used by seabirds, or fishing piers, which may draw in feeding birds (i.e. gulls). The gridwork will allow the observer to quickly fill in location identifiers during monitoring.

3.4 Monitoring Techniques

One qualified biologist shall be identified as the Lead Biologist. The Lead Biologist has the authority to stop pile driving when murrelets are detected in the monitoring area or when visibility impairs monitoring. The Lead Biologist is responsible for:

- Ensuring consistency with the criteria in the consultation;
- Communicating with monitoring crew(s), the pile driver operator, and the WFWO; and
- Determining monitoring start and end times.

An appropriate number of qualified observers will be positioned on shore and in boats to provide adequate coverage of the monitoring area to ensure no murrelets are in the monitoring area. Monitoring will begin at least 30 minutes prior to commencement of pile driving. Each qualified observer will cover an on shore station or boat transect that is no more than 50 m wide. All observers are responsible for:

- Understanding the requirements in the consultation and monitoring plan;
- Knowing the lines and method of communicating with the Lead Biologist and

boat operator (if an observer on the boat);

- Evaluating the sea conditions and visibility;
- Calibrating their ability to determine a 50 m distance at the beginning of each day. Calibration should be done using a range finder on a stationary object on the water; and
- Determining when conditions for monitoring are not met.

Monitoring will only occur when the sea state is at a Beaufort scale of 2 or less. The Beaufort scale is presented in Table 1 below. Observers should scan without a scope or binoculars; scopes and binoculars should only be used to verify species.

Observers will be positioned at land-based vantage points to scan for murrelets within the monitoring zone. The land-based vantage points must have an unobstructed view of the monitoring zone at all times. Each land-based observer can cover a 50 m area with a 180º arc. At least 2 full sweeps of the monitoring zone shall be conducted prior to pile driving to ensure that no murrelets are in the monitoring zone. Each boat observer is responsible for scanning from 0° (straight ahead of bow) to 90° left or right, depending upon which side of the boat they occupy. Observers should occasionally scan past 90°, looking for murrelets that may have surfaced behind the boat. Boat speed should be no less than 5 knots and no greater than 10 knots. Observer coverage should not be compromised; therefore, observer's ability to scan dictates the speed of the boat. Boat operators will not function as murrelet monitors while operating the boat.

If no murrelets are within the monitoring zone, the observers will notify the Lead Biologist who will communicate to the pile driver operator that pile driving may commence. During pile driving the observers on shore will continue scanning the area for murrelets. The observers in the boats will patrol and scan the monitoring area. All observers will have two-way radios with earpieces to allow for effective communication during pile driving. If murrelets are seen within the monitoring zone during pile driving, the observers will immediately notify the Lead Biologist who will communicate to the pile driver operator that he/she is to cease pile driving. Pile driving will not resume until the murrelets have left the monitoring area and at least 2 full sweeps of the monitoring area have confirmed murrelets are not present.

When a murrelet is detected within the monitoring area, it will be continuously observed until it leaves the monitoring area. If observers lose sight of the murrelet, searches for the murrelet will continue for at least 5 minutes. If the murrelet is still not found, then at least 2 full sweeps of the monitoring area to confirm no murrelets are present will be conducted prior to resumption of pile driving.

It is the observer's responsibility to determine if he/she is not able to see murrelets and inform the Lead Biologist that the monitoring needs to be terminated until conditions allow for accurate monitoring.

Murrelets are especially vulnerable to disturbance when they are molting and flightless. Molting occurs after nesting in late summer, typically July through October in Puget Sound populations. Extra precaution should be exercised during this period.

Table 1 – Beaufort Wind Scale develop in 1805 by Sir Francis Beaufort of England (0=calm to 12=hurricane)

Force	Wind (knots)	Classification	Appearance of wind effects on the water	Appearance of wind effects on land	Notes specific to on-water seabird observations
0	<1	Calm	Sea surface smooth and mirror like	Calm, smoke rises vertically	Excellent conditions, no wind, small or very smooth swell. You have the impression you could see anything.
1	1-3	Light air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes	Very good conditions, surface could be glassy (Beaufort 0), but with some lumpy swell or reflection from forests, glare, etc.
2	4-6	Light breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move	Good conditions, no whitecaps, texture/lighting contrast of water make murrelets more difficult to see. Surface could also be glassy or have small ripples, but with a short, lumpy swell, thick fog, etc.
3	7-10	Gentle breeze	Large wavelets, crests beginning to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended	Surveys cease, scattered whitecaps present, detection of murrelets definitely compromised, a hit-or-miss chance of seeing them owing to water choppiness and high contrast. This could also occur at lesser wind with a very short wavelength, choppy swell.
4	11-16	Moderate breeze	Small waves 0.3 to 1.1m becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move	Whitecaps abundant, sea chop bouncing the boat around, etc.
5	17-21	Fresh breeze	Moderate waves 1.1 to 2.0 m taking longer form, many whitecaps, some spray	Small trees begin to sway	

3.5 Limitations

No monitoring will be conducted during inclement weather that creates potentially hazardous conditions as determined by the Lead Biologist. Observers must have visibility to at least 50 m. No monitoring will be conducted when visibility is significantly limited such as during heavy rain, fog, glare or in a Beaufort sea state greater than 2.

Glare can significantly limit an observer's ability to detect birds. Boat orientation may be adjusted to reduce glare (e.g. change direction or reduce width of transects to 50 m with observers on only one side of boat). However, if visibility cannot be adjusted, monitoring and pile driving must cease until effective monitoring can be conducted.

Monitoring will not start until after sunrise and will cease prior to sunset. Specific timing restrictions may be in place per the consultation documents.

3.6 Documentation

The observers will document the number and general location of all murrelets in the monitoring area. Additional information on other seabirds and behaviors will be collected during documentation to improve general data knowledge on seabird presence and distribution as well as project impacts on various seabirds. Each observer will record information using the *Seabird Monitoring Data Collection Form* and reference completed *Seabird Monitoring Site/Transects Identification* and *Seabird Land-Based Monitoring Site Forms*. Forms are included in the Appendix.

Data Collection

All murrelets within transects or monitoring sites will be continuously documented during impacting activities. On the *Seabird Monitoring Data Collection Form*, document the time, number of birds, location, and observed behavior (See Example Dolphin Repair). Update the documentation when a murrelet changes behavior, changes location, or leaves the area. To the extent possible, the observers will also record each murrelet "take" incident observed, as defined in the final Biological Opinion. This may include obvious disturbance responses from pile driving or other construction activities, and injury or mortality that can be attributed to project-related activities.

Observers will also note all seabirds within the area that appear to be acting abnormally during any project activities. For example, if a seabird is listing, paddling in circles, shaking head, or suddenly flushing at the onset of activity, note the information on the *Seabird Monitoring Data Collection Form.* For all birds except murrelets, providing a genus level (grebe, loon, cormorant, scoter, gull, etc) of identification is sufficient.

General information on other seabird behavior and distribution within the monitoring area will be collected. Every two hours at minimum during pile driving activities, the observer will document other seabird presence, behavior, and distribution in the monitoring area. This information can be collected more frequently. Many seabirds may linger in an area for several hours. If this is the case, note the time, species, and in the

comments section identify that this is the same group from earlier and document any notable changes in behavior.

Under location, the data form indicates two separate options for documenting location. Land-based observers can fill out the land-based only or both land-based and boat sections. The land-based location will be based on the grid drawn out on the *Seabird Land-Based Monitoring Site Form* (See Example Dolphin Repair). For the boat transect locations, identify the distance in meters from the boat to the seabird and whether it is landward (toward activity) or seaward (away from activity).

Example Dolphin Repair

Seabird Monitoring Site/Transect Identification Form

Project Name

Dolphin repair

Monitoring Dates

November 8, 9, 10, 2012

Number of Monitoring Sites/Transects

4

Insert aerial photo of entire monitoring project area. Identify each monitoring site/station reflecting 50 meter zones for each observer. For example, if there are two observers on a boat transect, the box will be 100 meters wide. Some monitoring stations will overlap and should be indicated here.

Seabird Land-Based Monitoring Site Form

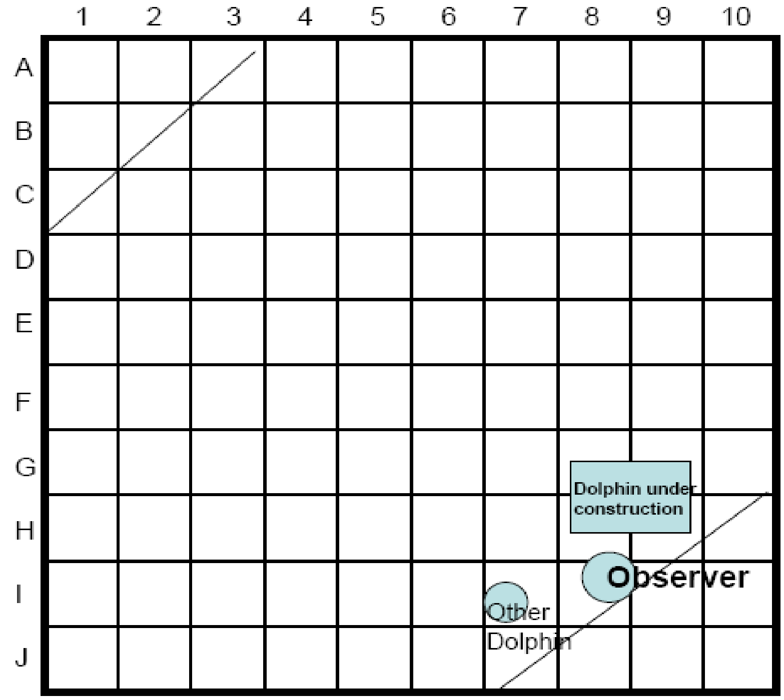
Project Name Dolphin Repair **Date** 11/10/12

Land Based Monitoring Site ID Station #4

For each monitoring station referenced in the main map grid, sketch the coastline using the 5 meter squares. Indicate the direction to where impacting activities are occurring.

Use space below to describe additional monitoring site details that may be pertinent such as other structures seabirds may use.

Observer located at end of terminal pier adjacent to construction activities. There is another dolphin to the west currently used by cormorants.



Seabird Monitoring Data Collection Form

Date

Project Name Dolphin Repair **Monitoring Site/Transect ID** Land Based Station #4

Observers Harry Downy

Activity Pile Driving **Time and Duration** 10:30 am to 4:00 pm

Time	Species	# of birds	Wind speed (Beaufort Marine scale)	Land Observer	Boat Observer		Observed Behavior*	Comments
				Grid Location	Distance	Land/Sea Ward		
10 am	scoters	10	2	C6			R	
10 am	cormorants	20	2	I8			R, P	Hanging out on adjacent dolphin
11:15 am	marbled murrelet	1	1	B4			F	Pile driving ceased, MM left observation area at 11:20
12:00 pm	grebe	2	2	G6			P	
12:00 pm	cormorants	20	2	I8			R, P	Hanging out on adjacent dolphin
2:00	gulls	15	1	H10			F	Group attracted by fisherman dumping guts
2:00	cormorants	20	1	I8			R, P	Hanging out on adjacent dolphin
4:00	gulls	5	2	H10			F	Residuals from earlier
4:00	cormorants	20	2	I8			R, P	Hanging out on adjacent dolphin

* R=resting, F=feeding/diving, P=preening, Y=flying/flushing, T=transient, N=nesting, O=other

Seabird Monitoring Data Collection Form **Date** 11/10/12

Project Name Dolphin Repair **Monitoring Site/Transect ID** Land Based Station #4

Observers Jimmy Jones

Activity Pile Driving **Time and Duration** 10:30 am to 4:00 pm

Time	Species	# of birds	Wind speed (Beaufort Marine scale)	Land Observer	Boat Observer		Observed Behavior*	Comments
				Grid Location	Distance	Land/Sea Ward		
10 am	grebe	1	2		25	sea	T	
11:25	marbled murrelet	1	1		45	land	F	Pile driving ceased at 11:15, left monitoring area at 11:45
12:00	scoters, loon	8	1		15	land	R, P	Startled by pile driving re-start, flushed out of area
12:00	common murre	2	1		25	sea	T	Startled by pile driving re-start, flushed out of area
2:00	gulls	1	2		75	sea	T	
4:00	gulls	5	2		50	sea	T	

* R=resting, F=feeding/diving, P=preening, Y=flying/flushing, T=transient, N=nesting, O=other

3.7 Timing and Duration

Pile driving cannot start until the monitoring pre-sweep has been conducted. The pre-sweep monitoring can commence once there is enough daylight for adequate visibility, and must begin at least 30 minutes before the initiation of pile driving. Monitoring will then continue until pile driving is completed each day. The monitoring set-up (i.e., number and location of observers) should allow for the entire monitoring are to be covered within five minutes.

3.8 Contingency

In the unlikely event that a murrelet is perceived to be injured by pile driving, all pile driving will cease and WFWO will be contacted as soon as possible.

The Lead Federal Action Agency will work with WFWO to make necessary changes to the monitoring plan as described in section 2.0 above. Pile driving cannot resume until the plan has been amended, unless the WFWO cannot be reached, then the Lead Biologist determines the course of action and continues to ensure consistency with the consultation.

4.0 Beach Surveys

Searches for diving seabird carcasses along nearby beaches will be conducted following pile driving activities. The biologist will walk accessible beaches within 0.5 mile of the pile driving location. Beach surveys will be conducted during low or receding tides, if possible, to maximize the chances of finding beached carcasses. Beach surveys will be conducted each day following in-water impact pile driving (as is practical based on the timing of tide events and pile driving activities.) Beach surveys are of secondary priority and will not be conducted if such activities would interfere with the implementation of murrelet monitoring or if the timing of low/receding tides imposes unreasonable schedule demands on the biologist.

Any dead murrelets or other diving seabirds found during the beach surveys (or during monitoring activities) will be collected by monitoring staff and delivered, as soon as possible, to the WFWO in Lacey, Washington for examination. Collected carcasses will be put in plastic bags, and kept cool (but not frozen) until delivery to the WFWO. Surveyors will follow the chain-of-custody process included in the consultation documents.

5.0 FWS Communication

Prior to the initiation of monitoring the Lead Federal Action Agency and a representative from the WFWO will meet to review the proposed monitoring locations and any logistical concerns that may have developed during monitoring preparation. The Lead Federal Action Agency will keep the WFWO informed of the progress and effectiveness of the monitoring activities and of the number and disposition of murrelet take that is documented throughout the duration of the project.

The Lead Federal Action Agency will notify the WFWO of any problems and/or necessary modification to the monitoring plan. The Lead Federal Action Agency will coordinate with the WFWO in the development of a modified approach and will obtain WFWO approval for such modifications.

Primary points of contact at the WFWO are:

1. Consulting Biologist – phone:
2. Emily Teachout – phone: (360) 753-9583
3. Deanna Lynch – phone: (360) 753-9545

6.0 Personnel Qualifications and Training

All observers must be certified under the Marbled Murrelet Marine Protocol. Observers will have appropriate qualifications, including education or work experience in biology, ornithology, or a closely related field; at least one season (2-3 months) of work with bird identification being the primary objective (i.e. not incidental to other work). Observers must have experience identifying marine birds in the Pacific Northwest, as well as understanding and documenting bird behavior.

All observers will attend the marbled murrelet marine monitoring protocol training and pass the written and photo examination with 90% proficiency. Upon successful completion, observers will be certified. Certification is valid for one year.

Recertification is required annually, unless the observer can document that he/she implemented the monitoring protocol for at least 25 monitoring days in the previous year. Recertification can then be delayed for one year; however, recertification can only be delayed for one year.

Certifications will be considered expired after one year, unless the WFWO is notified by the biologist that greater than 25 days of survey were done within one year of their certificate date. If an observer does conduct greater than 25 days of survey the certificate will be valid for an additional year from the certificate date. To extend a certification the biologist sends an email to the attention of Emily Teachout (emily_teachout@fws.gov) with the dates of the surveys they conducted and the date of their original certificate. The WFWO will maintain a list a certified observers and it will be available on our website.

The Lead Federal Agency is expected to provide all observers with a copy of the consultation documents for the project. Observers must read and understand the contents of the consultation documents related to identifying, minimizing, and reporting "incidental take" of murrelets.

7.0 Reporting

At the completion of each in-water work window for which there has been impact pile driving, the Lead Federal Action Agency will forward a monitoring report to the WFWO within 30 days. Reports shall be sent to the attention of (WFWO Branch Manager). The report shall include:

- Observation dates, times, and conditions
- Description of the any "take" (as described in the final Biological Opinion) identified by the biologist
- Copies of field data sheets or logs

Note: Questions and comments regarding this protocol should be directed to Emily Teachout at the USFWS, Washington Fish and Wildlife Office (360-753-9583); emily_teachout@fws.gov

APPENDIX

Print Form

Seabird Monitoring Site/Transect Identification Form

Project Name

Monitoring Dates

Number of Monitoring Sites/Transects

Insert aerial photo of entire monitoring project area. Identify each monitoring site/transect. Each monitoring station will reflect the 50 meter zone for each observer. For example, if there are two observers on a boat transect, the box will be 100 meters wide. Some monitoring stations will overlap and should be indicated here.

Seabird Land-Based Monitoring Site Form

Project Name ______________________________ **Date** ____________________

Land Based Monitoring Site ID ______________________________

For each monitoring station referenced in the main map grid, sketch the coastline using the 5 meter squares. Indicate the direction to where impacting activities are occurring.

Use space below to describe additional monitoring site details that may be pertinent such as other structures seabirds may use.

	1	2	3	4	5	6	7	8	9	10
A										
B										
C										
D										
E										
F										
G										
H										
I										
J										

Seabird Monitoring Data Collection Form

Date____________________

Project Name ____________________________ Monitoring Site/Transect ID ________________________

Observers____

Activity ______________________________ Time and Duration________________________________

Time	Species	# of birds	Wind speed (Beaufort Marine scale)	Land Observer	Boat Observer		Observed Behavior*	Comments
				Grid Location	Distance	Land/Sea Ward		

* R=resting, F=feeding/diving, P=preening, Y=flying/flushing, T=transient, N=nesting, O=other

APPENDIX B: HYDROACOUSTIC MONITORING PLAN

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Mukilteo Multimodal Project – Phase 2
UNDERWATER NOISE MONITORING PLAN

Prepared by:
Jim Laughlin
Manager Air Quality, Noise and Energy Section
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____
Jim Laughlin

9/21/16

INTRODUCTION

The Washington State Ferries (WSF) proposes to construct the new Mukilteo Multimodal ferry terminal in Phase II and completely remove the existing berthing structures at the existing Mukilteo Ferry Terminal. Construction activities will consist of earthwork, retaining wall construction, soil contamination remediation, surveying, installing signals at two intersections, roadway construction, utility work, the construction of berthing structures, an overhead walkway and a terminal building. The work includes permanent landscaping and architectural elements, constructing all four of the planned toll booths, constructing seven of the planned holding lanes, constructing a transit station, the installation of the supervisor's office, and a fishing pier.

The three types of piles proposed for this project that will be driven with an impact hammer include 30-inch diameter steel pipe piles as part of the trestle, dolphins, and part of the terminal building, 24-inch steel pipe piles used to support a temporary pier access, construct wingwalls, and construct the public fishing pier and 12-inch diameter steel H-piles for a mechanically stabilized earth wall which will be driven upland above the MHHW.

Most of the steel pipe pile will be driven with a vibratory hammer, and then proofed with an impact hammer. Of the 30-inch diameter steel piles, up to 25 piles associated with the trestle structure will be primarily driven with an impact hammer (although that number could be less than 3); however, if piles are driven entirely with an impact hammer, the estimated number of strikes per piles is 3500.

A bubble curtain will be used where feasible during the installation of the steel pipe piles.

PROJECT AREA

The new Mukilteo Multimodal Terminal will be located east of the existing Mukilteo terminal. See vicinity maps shown in Figure 1 and Figure 2.

Figure 1. Vicinity map of Mukilteo Multimodal Terminal Project.

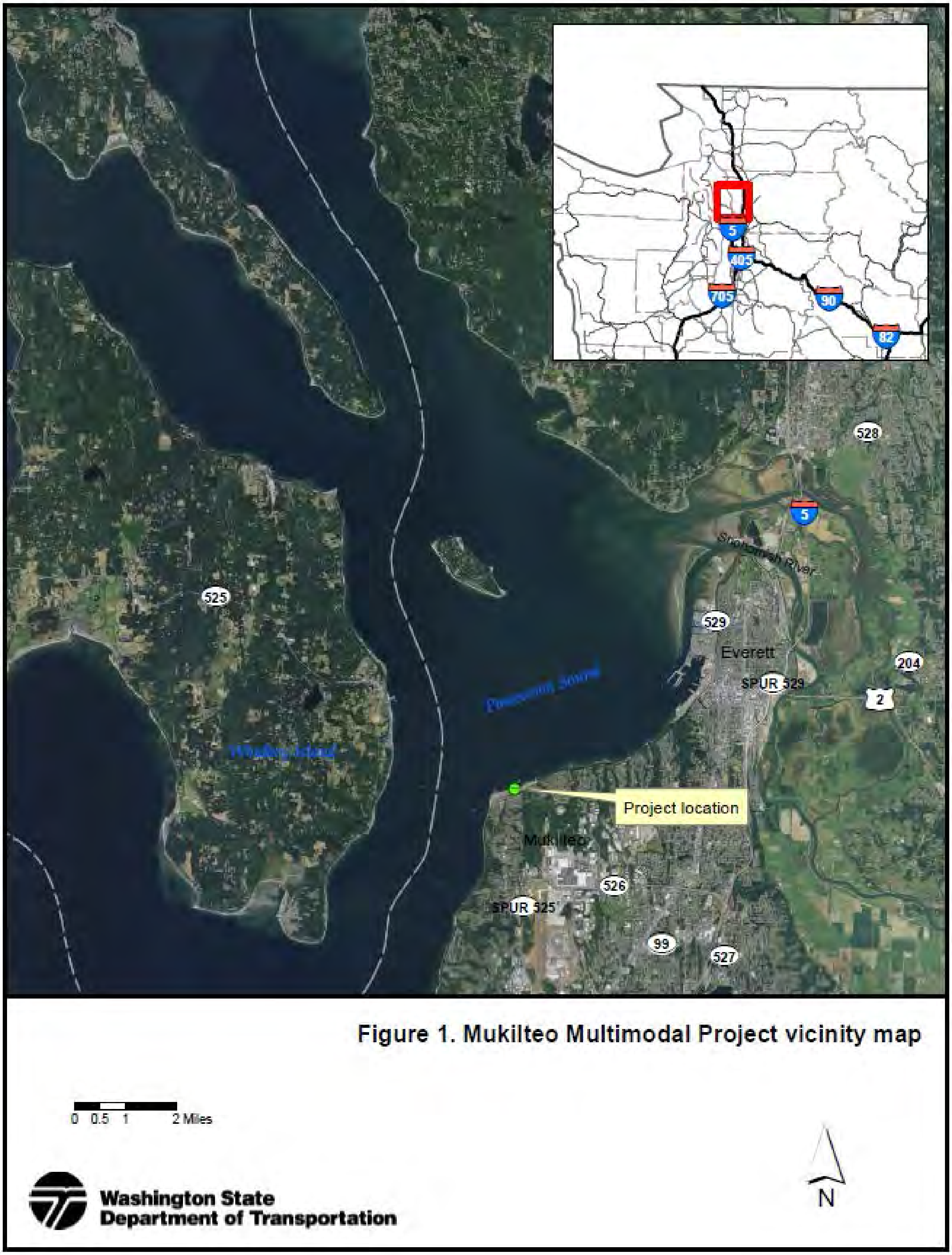


Figure 2. Location of new Mukilteo Multimodal Terminal.

PERMIT/ESA CONDITIONS

Please refer to the USFWS and NOAA Fisheries Biological Opinion for permit and ESA conditions for this project.

PILE INSTALLATION LOCATION

Figure 3 indicates the location of the Mukilteo Multimodal Phase 2 piles to be installed. There will be two 24-inch diameter steel pipe piles, three 30-inch diameter steel pipe piles. Figure 4 indicates the approximate location of the three 12-inch diameter steel H-piles to be monitored.

Figure 3. Approximate location of steel pipe piles to be impact driven for the Mukilteo Multimodal Phase 2 Project (yellow) and the approximate location of the hydrophones (stars).

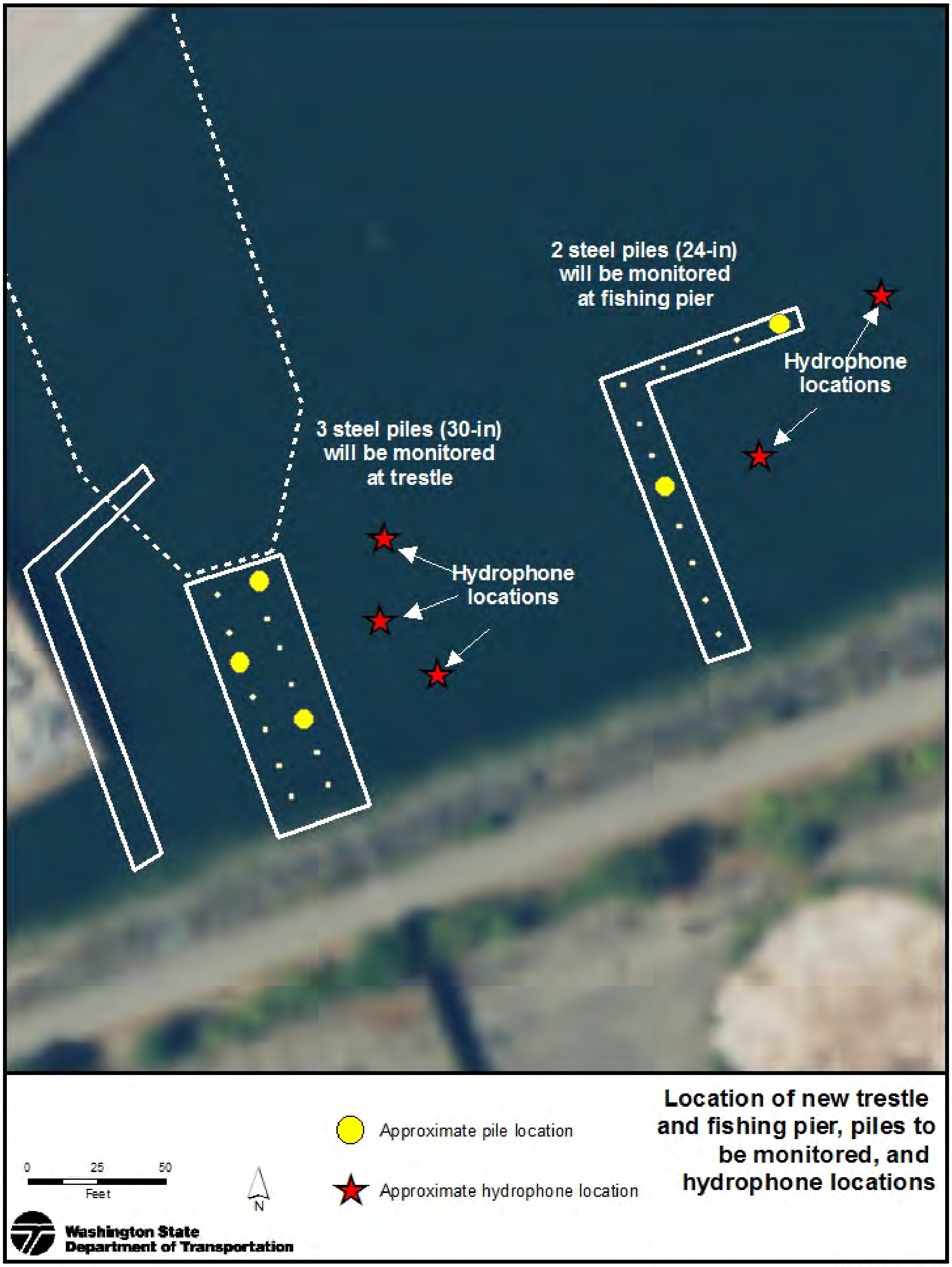
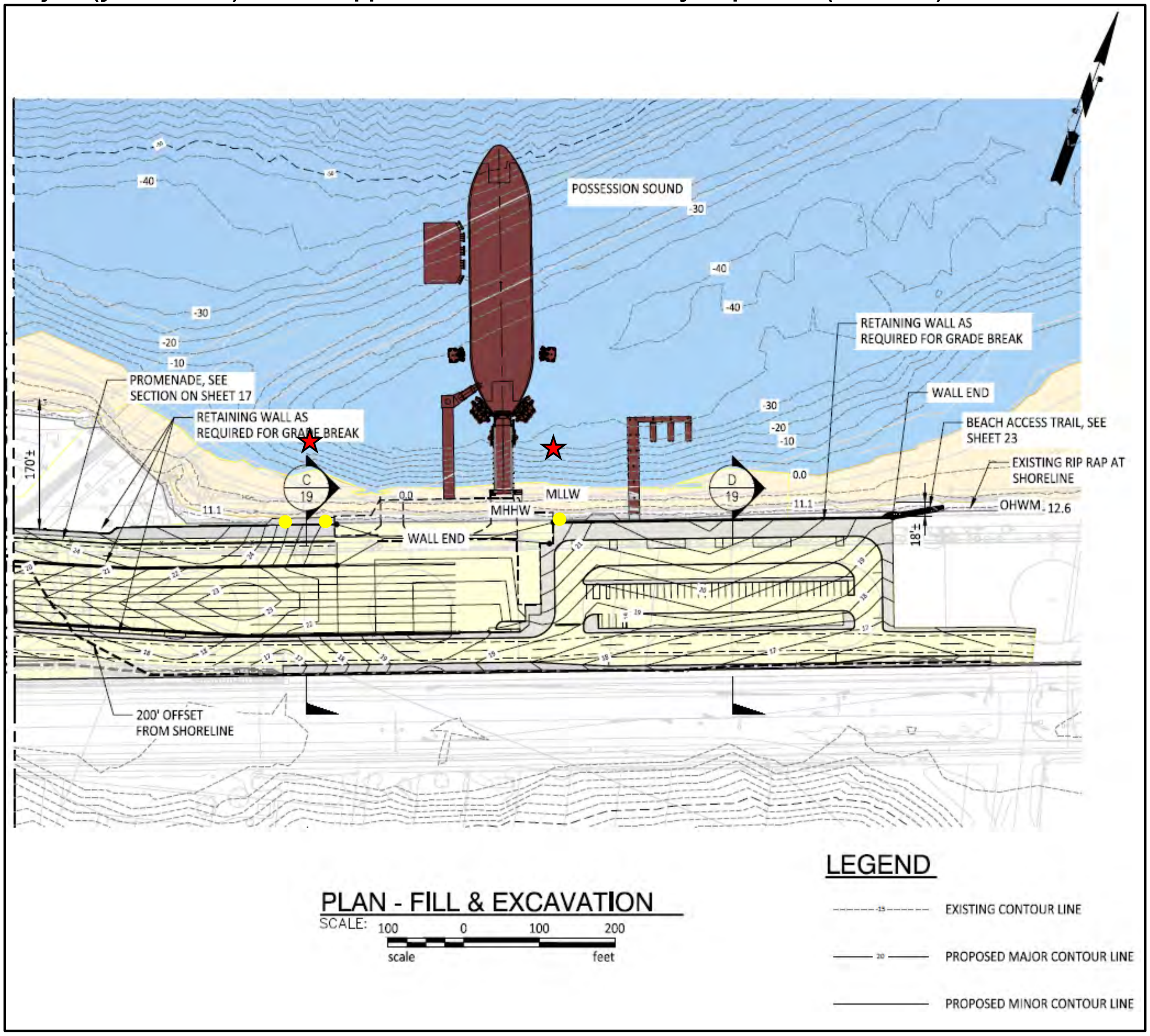


Figure 4. Approximate location of steel H-piles to be impact driven for the Mukilteo Multimodal Project (yellow dots) and the approximate location of the hydrophones (red stars).



PILE INSTALLATION

Impact Pile Driving for Fish and Marbled Murrelet Consultations

Hydroacoustic monitoring will be conducted for two 24-inch steel pipe piles, three 30-inch steel pipe piles and three 12-inch steel H-piles during impact driving. Hydroacoustic monitoring of the piles during impact driving will include:

- Monitoring 5 steel pipe piles at 10 meters range and if appropriate at 3H range where H is the water depth at the pile including two of the 24-inch steel piles and three of the 30-inch steel piles.
- Monitoring of 3 steel H-piles.
- Airborne monitoring of the impact driving of the piles.

Figures 3 and 4 indicates the location of the piles to be monitored and the approximate hydrophone locations for each pile being monitored. All hydrophones will be placed at least 1 m (3.3 feet) below the water surface. One hydrophone will be placed at a nominal distance of 10 meters from the hydrophone being monitored at mid-water depth. If appropriate a second hydrophone will be placed at a distance of 3H where H is the water depth at the pile being monitored and at a depth of 0.8 percent of the water depth at 3H. Hydrophones will be located with a clear acoustic line-of-sight between the pile and the hydrophone.

Table 1 lists the piles to be installed, the approximate water depth, and the number and size of piles that will be installed. Table 2 lists the equipment specifications that will be used during monitoring.

Table 1
Water Depth and Number Piles to be Monitored

Structure	Approximate Water Depth (ft)	Number and Size of Piles
Trestle and Terminal building	18	(3) 30-inch steel pipe piles
Temporary Access Pier	18	(2) 24-inch steel pipe piles
Mechanically Stabilized Earth Wall	Above MHHW (upland)	(3) 12-inch steel H-piles

Table 2

Equipment for underwater sound monitoring (hydrophone, signal amplifier, and calibrator). All have current National Institute of Standards and Technology (NIST) traceable calibration.

Item	Specifications	Minimum Quantity	Usage
Hydrophone	Receiving Sensitivity- -211dB re 1V/μPa	1	Capture underwater sound pressures near the source and convert to voltages that can be recorded/analyzed by other equipment.
Signal Conditioning Amplifier	Amplifier Gain- 0.1 mV/pC to 10 V/pC Transducer Sensitivity Range- 10-12 to 103 C/MU	1	Adjust signals from hydrophone to levels compatible with recording equipment.
Calibrator (pistonphone-type)	Accuracy- IEC 942 (1988) Class 1	1	Calibration check of hydrophone in the field.
Digital Signal Analyzer	Sampling Rate- 48kHz or greater	1	Analyzes and transfers digital data to laptop hard drive.
Laptop computer or Digital Audio Recorder	Compatible with digital signal analyzer	1	Record digital data on hard drive or digital tape.
Real Time and Post-analysis software	-	1	Monitor real-time signal and post-analysis of sound signals.

Item	Specifications	Minimum Quantity	Usage
Airborne Noise Meter (free field type 1)	Range: 30 – 120 dBA Sensitivity: -29 dB ± 3 dB (0 dB = 1 V/Pa)	1	Monitor airborne sound levels for possible human impacts (if not raining)

To facilitate further analysis of data, full bandwidth, time-series underwater signal shall be recorded as a text file (.txt) or wave file (.wav) or similar format. Recorded data shall not use data compression algorithms or technologies (e.g. MP3, compressed .wav, etc.).

METHODOLOGY

Impact Pile Driving Monitoring for Fish and Marbled Murrelet Consultations

Up to two hydrophones will be placed, one at midwater depth at a distance of 10 meters and if applicable a second at a distance of 3H, where H is the water depth at the pile and a depth of 0.8 of the water depth at 3H from each pile being monitored. A weighted tape measure will be used to determine the depth of the water. The hydrophones will be attached to a nylon cord. The nylon cord will be attached to an anchor that will keep the line the appropriate distance from each pile. The nylon cord or chain will be attached to a float or tied to a static line at the surface. The distances will be measured by a tape measure, where possible, or a range-finder. The acoustic path (line of sight) between the pile and the hydrophones will be unobstructed in all cases.

The hydrophone calibration will be checked at the beginning of each day of monitoring activity. The monitoring software (RTPro, v7.1) is used in combination with the Pistonphone calibrator to determine the correction factor for each hydrophone. The hydrophone correction factor must be less than 0.2 dB to be acceptable. Prior to the initiation of pile driving, the hydrophone will be placed at the appropriate distance and depth as described above.

The onsite inspector/contractor will inform the acoustics specialist when pile driving is about to start to ensure that the monitoring equipment is operational. Underwater sound levels will be continuously monitored during the entire duration of each pile being driven with a minimum one-third octave band frequency resolution. The wideband instantaneous absolute peak pressure and Sound Exposure Level (SEL) values of each strike and an estimate of the daily cumulative SEL should be monitored in real time during construction to ensure that the project does not exceed its authorized take level. Peak and RMS pressures will be reported in dB (re:1 μPa). SEL will be reported in dB (re: 1 $\mu Pa^2 \cdot sec$).

Prior to, and during, the pile driving activity, environmental data will be gathered, such as water depth and tidal level, wave height, and other factors that could contribute to influencing the underwater sound levels (e.g. aircraft, boats, etc.). Start and stop time of each pile driving event will be logged.

The contractor will provide the following information, in writing, to the noise specialist conducting the hydroacoustic monitoring for inclusion in the final monitoring report: a description of the substrate composition, approximate depth of significant substrate layers, hammer model and size, pile cap or cushion type, hammer energy settings and any changes to those settings during the piles being monitored, depth pile driven, blows per foot for the piles monitored, and total number of strikes to drive each pile that is monitored.

Ambient airborne noise levels will be monitored for a minimum of 15-minutes in the absence of construction activities to determine background airborne sound levels (if not raining). Type 1 sound level meters will be programmed to make 1-second measurements every 1 seconds and record the L_{max}, L_{eq} and L_{95}, thus capturing all, of the individual pile strikes.

Airborne noise measurements will be made for piles identified in Figures 3 and 4 and at a distance between 50 feet and 200 feet from the pile depending on the availability of a suitable location to place the noise meter. Notes will be made regarding any anomalous noise events such as boats and low flying commercial aircraft. These events will be noted on the data sheets but excluded from the results.

Sound Attenuation Monitoring

None of the monitored piles will be tested with the sound attenuation off (or absence) to test its effectiveness[9].

SIGNAL PROCESSING

Impact Pile Driving Monitoring for Fish and Marbled Murrelet Consultations

Post-analysis of the underwater pile driving sounds will include:

- Number of pile strikes per pile and per day.
- For each recorded strike (or each strike from a subset), determine the following:
  - The peak pressure, defined as the maximum absolute value of the instantaneous pressure (overpressure or underpressure).
  - The root mean squared sound pressure across 90% of the strikes energy ($RMS_{90\%}$).
  - Sound exposure level, measured across 90% of the accumulated sound energy ($SEL_{90\%}$). Calculation methodology is provided in Appendix A.
  - Both broadband and marine mammal functional hearing group analysis.
- Maximum, mean, and range of the peak pressure with attenuation.
- Maximum, mean, range, and Cumulative Distribution Function (CDF) of the $RMS_{90\%}$, with attenuation where the CDF is used to report the percentage of $RMS_{90\%}$ values above the thresholds.
- Maximum, mean, and range of the $SEL_{90\%}$, with attenuation.
- Cumulative SEL (cSEL) across all of the pile strikes. If SEL was calculated for all strikes, cSEL is estimated as indicated in Appendix A. If SEL was calculated for a subset of strikes, cSEL is estimated as follows: cSEL = SEL_{mean} + 10*log(total # strikes).

[9] Note: There may be circumstances where the U.S. Fish and Wildlife Service determines that unattenuated pile driving (striking the pile with the bubble curtain turned off) would pose a significant risk of injury to marbled murrelets. In those situations, the Service may request that unattenuated pile driving does not occur and that hydroacoustic monitoring be conducted to determine the extent at which certain thresholds are met instead. This will need to be determined on a case by case basis for projects that may affect marbled murrelets.

- A frequency spectrum between a minimum of 20 and 20 kHz for up to eight successive strikes with similar sound levels.

ANALYSIS

Impact Pile Driving Monitoring for Fish and Murrelet Consultations

Analysis of the data from the San Francisco-Oakland Bay Bridge Pile Installation Demonstration project (PIDP) indicated that 90 percent of the acoustic energy for most pile driving impulses occurred over a 50 to 100 millisecond period with most of the energy concentrated in the first 30 to 50 milliseconds (Illingworth and Rodkin, 2001). The RMS values computed for this project will be computed over the duration between where 5% and 95% of the energy of the pulse occurs. The SEL energy plot will assist in interpretation of the single strike waveform. The single strike SEL associated with the highest absolute peak strike along with the total number of strikes per pile and per day will be used to calculate the cumulative SEL for each pile and each 24-hour period.

In addition a waveform analysis of the individual absolute peak pile strikes will be performed to determine any changes to the waveform with the bubble curtain. Units of underwater sound pressure levels will be dB (re:1 μPa) and units of SEL will be re:1 $\mu Pa^{2} \bullet sec$. In addition to a full broadband analysis the data will be analyzed for each marine mammal functional hearing group (Southall et al., 2007).

Analysis of the airborne noise levels will be a plot of the L_{max}, L_{eq} and L_{95} over the duration of each pile driving event.

REPORTING

Preliminary results for the daily monitoring activities, if required, will be submitted/reported to the primary point of contact[10] at each of the Services within 24 hours after monitoring concludes for the day. In addition a final draft report including data collected and summarized from all monitoring locations will be submitted to the Services within 90 days of the completion of hydroacoustic monitoring. The results will be summarized in graphical form and include summary statistics and time histories of impact sound values for each pile. A final report will be prepared and submitted to the Services within 30 days following receipt of comments on the draft report from the Services. The report shall include:

1. Size and type of piles.
2. A detailed description of the bubble curtain, including design specifications if applicable.
3. The impact hammer energy rating used to drive the piles, make and model of the hammer.
4. A description of the sound monitoring equipment.

[10] The primary point of contact is the biologist that conducted the Section 7 consultation for the Service(s). In the event that the consulting biologist is not available, communication regarding monitoring results and reports should be addressed to the manager of the consultation branch or division with a reference to the consultation title.

5. The distance between hydrophones and piles.
6. The depth of the hydrophones and depth of water at hydrophone locations.
7. The distance from the pile to the water's edge.
8. The depth of water in which the pile was driven.
9. The physical characteristics of the bottom substrate into which the piles were driven.
10. The total number of strikes to drive each pile and for all piles driven during a 24-hour period.
11. The underwater wideband background sound pressure level reported as the 50% CDF.
12. The results of the hydroacoustic monitoring, as described under Signal Processing including an analysis of the marine mammal functional hearing groups. An example table is provided in Appendix C for reporting the results of the monitoring.
13. The results of the airborne monitoring, including the frequency spectrum, the Lmax, L_{eq} and L_{90} for each pile strike for each pile including time history plots, and an estimation of the received levels at the nearest residences
14. The distance at which peak, cSEL, and RMS values exceed the respective threshold values.
15. A description of any observable fish, marine mammal, or bird behavior in the immediate area will and, if possible, correlation to underwater sound levels occurring at that time.

REFERENCES

Illingworth and Rodkin, Inc. 2001. Noise and Vibration Measurements Associated with the Pile Installation Demonstration Project for the San Francisco-Oakland Bay Bridge East Span, Final Data Report, Task Order 2, Contract No. 43A0063.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals 33(4): 411-521.

APPENDIX A

Calculation of Cumulative SEL

An estimation of individual SEL values can be calculated for each pile strike by calculating the following integral, where T is T_{90}, the period containing 90% of the cumulative energy of the pulse (eq. 1).

$$SEL = 10\log\left(\int_0^T \frac{p^2(t)}{{p_0}^2} dt \right) \quad dB \qquad \text{(eq. 1)}$$

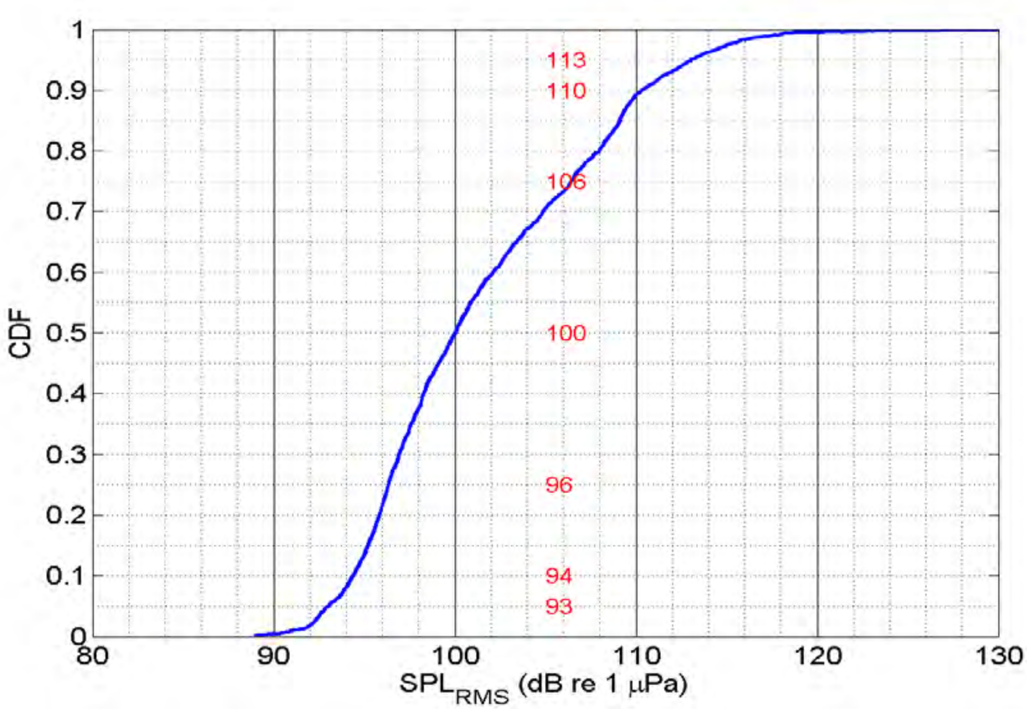
Calculating a cumulative SEL from individual SEL values cannot be accomplished simply by adding each SEL decibel level arithmetically. Because these values are logarithms they must first be converted to antilogs and then accumulated. Note, first, that if the single strike SEL is very close to a constant value (within 1 dB), then cumulative SEL = single strike SEL + 10 times log base 10 of the number of strikes N, i.e., $10Log_{10}(N)$. However if the single strike SEL varies over the sequence of strikes, then a linear sum of the energies for all the different strikes needs to be computed. This is done as follows: divide each SEL decibel level by 10 and then take the antilog. This will convert the decibels to linear units (or $uPa^2 \bullet s$). Next compute the sum of the linear units and convert this sum back into dB by taking $10Log_{10}$ of the value. This will be the cumulative SEL for all of the pile strikes.

APPENDIX B

Calculation of a Cumulative Distribution Function and Plot for Background Sound Level Analysis

Data from three full 24-hour underwater measurement cycles (minimum) are used to calculate a 30-second Root Mean Square (RMS) value for each 30-second period for the entire dataset. The RMS should be calculated for both the full frequency range recorded as well as a separate dataset, which has been passed through a high pass filter thus eliminating those frequencies below 1000 Hz. These datasets are then grouped into 24-hour periods. To determine if the data is approximately log-normal in distribution, each 24-hour period is plotted as a Probability Density Function (PDF). Each 24-hour period can be plotted on the same PDF plot. The plots should be approximately log normal in distribution and thus can be used in the further analysis. Each day of data should have an approximately Gaussian sigmoid shape, the differences between them and the ideal might be hard to spot, but the sigmoid from day to day will show noticeable variation. Data, which does not approximate a log normal distribution, should be excluded from further analysis.

The Cumulative Distribution Function (CDF) plot is obtained by plotting the normalized cumulative sum vs. the bin location. You can also get the PDF from plotting the normalized bin count vs. the bin location. The normalized bin count is obtained by dividing the count column by (number of data points multiplied by the space between 2 consecutive bins). This provides the integral of the PDF equal to 1. For instructions on creating a histogram in Microsoft Excel, see: http://www.vertex42.com/ExcelArticles/mc/Histogram.html



APPENDIX C

Table 1. Example table for required information for reporting the results of hydroacoustic monitoring of pile driving.

Date and Time	Pile ID	Hammer Impact or Vibratory	# Strikes or Vibratory Seconds	Distance to Pile from Hydrophone (m)	Water Depth (m)		Peak (dB)			$SEL_{90\%}$ (dB)				$RMS_{90\%}$ (dB)			Notes
					At Pile	At H-phone	Max	Min	Mean	Max	Min	Mean	$cSEL_{90\%}$	Max	Min	Mean	

APPENDIX C: STATUS OF THE SPECIES: MARBLED MURRELET

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APPENDIX C
STATUS OF THE SPECIES: Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratus*) (murrelet) was listed by the U.S. Fish and Wildlife Service (Service) as a threatened species in Washington, Oregon, and California in 1992. The primary reasons for listing included extensive loss and fragmentation of the older-age forests that serve as nesting habitat for 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 (75 FR 3424 [Jan. 21, 2010]).

Life History

The murrelet is a small, fast-flying seabird in the Alcidae family that occurs along the Pacific coast of North America. Murrelets forage for small schooling fish or invertebrates in shallow, nearshore, marine waters and primarily nest in coastal older-aged coniferous forests. The murrelet lifespan is unknown, but is expected to be in the range of 10 to 20 years based on information from similar alcid species (De Santo and Nelson 1995, pp. 36-37). Murrelet nesting is asynchronous and spread over a prolonged season. In Washington, the murrelet breeding season extends from April 1 to September 23. Egg laying and incubation occur from April to early August and chick rearing occurs between late May and September, with all chicks fledging by late September (Hamer et al. 2003; USFWS 2012a).

Murrelets lay a single-egg which may be replaced if egg failure occurs early in the nesting cycle, but this is rare (Nelson 1997, p. 17). During incubation, one adult sits on the nest while the other forages at sea. Adults typically incubate for a 24-hour period, then exchange duties with their mate at dawn. Chicks hatch between May and August after 30 days of incubation. Hatchlings appear to be brooded by an adult for several days (Nelson 1997, p. 18). Once the chick attains thermoregulatory independence, both adults leave the chick alone at the nest for the remainder of the rearing period, except during feedings. Both parents feed the chick, which receives one to eight meals per day (Nelson 1997, p. 18). Most meals are delivered early in the morning while about a third of the food deliveries occur at dusk and intermittently throughout the day (Nelson and Hamer 1995, p. 62).

Murrelets and other fish-eating alcids exhibit wide variations in nestling growth rates. The nestling stage of murrelet development can vary from 27 to 40 days before fledging (De Santo and Nelson 1995, p. 45). The variations in alcid chick development are attributed to constraints on feeding ecology, such as unpredictable and patchy food distributions, and great distances between feeding and nesting sites (Øyan and Anker-Nilssen 1996, p. 830). Food limitation during nesting often results in poor growth, delayed fledging, increased mortality of chicks, and nest abandonment by adults (Øyan and Anker-Nilssen 1996, p. 836).

Murrelets are believed to be sexually mature at 2 to 4 years of age (Nelson 1997, p. 19). Adult birds may not nest every year, especially when food resources are limited. Recent monitoring efforts in Washington indicated that only 20 percent of monitored murrelet nesting attempts were successful, and only a small portion of the 158 tagged adult birds actually attempted to nest (13

percent) (Raphael and Bloxton 2009, p. 165). The low number of adults attempting to nest is not unique to Washington. Some researchers suspect that the portion of non-breeding adults in murrelet populations can range from about 5 percent to 70 percent depending on the year, but most population modeling studies suggest a range of 5 to 20 percent (McShane et al. 2004, p. 3-5).

Murrelets in the Marine Environment

Marbled murrelets spend most (>90 percent) of their time at sea. Their preferred marine habitat includes sheltered, nearshore waters within 3 miles of shore, although they occur farther offshore in areas of Alaska and during the nonbreeding season (Huff et al. 2006, p. 19). They generally forage in pairs on the water, but they also forage solitarily or in small groups.

Breeding Season

The murrelet is widely distributed in nearshore waters along the west coast of North America. It occurs primarily within 5 km of shore (Alaska, within 50 km), and primarily in protected waters, although its distribution varies with coastline topography, river plumes, riptides, and other physical features (Nelson 1997, p. 3). Murrelet marine distribution is strongly associated with the amount and configuration of terrestrial nesting habitat (Raphael et al. 2015c, p. 17). In other words, they tend to be distributed in marine waters adjacent to areas of suitable breeding habitat. Non-breeding adults and subadults are thought to occur in similar areas as breeding adults. This species does occur farther offshore, but in much reduced numbers (Strachan et al. 1995, p. 247). Their offshore occurrence is probably related to current upwelling and plumes during certain times of the year that tend to concentrate their prey species.

Winter Range

The winter range of the murrelet is poorly documented, but they are present near breeding sites year-round in most areas (Nelson 1997, p. 3). Murrelets exhibit seasonal redistributions during non-breeding seasons. Generally more dispersed and found farther offshore in winter in some areas, although highest concentrations still occur close to shore and in protected waters (Nelson 1997, p. 3). In some areas, murrelets move from the outer exposed coasts of of Vancouver Island and the Straits of Juan de Fuca into the sheltered and productive waters of northern and eastern Puget Sound. Less is known about seasonal movements along the outer coasts of Washington, Oregon, and California (Ralph et al. 1995, p. 9). The farthest offshore records of murrelet distribution are 60 km off the coast of northern California in October, 46 km off the coast of Oregon in February (Adams et al. 2014) and at least 300 km off the coast in Alaska (Piatt and Naslund 1995, p. 287). Known areas of winter concentration include and southern and eastern end of Strait of Juan de Fuca (primarily Sequim, Discovery, and Chuckanut Bays), San Juan Islands and Puget Sound, WA (Speich and Wahl 1995, p. 314).

Foraging and Diet

Murrelets dive and swim through the water by using their wings in pursuit of their prey; their foraging and diving behavior is restricted by physiology. They usually feed in shallow, nearshore water <30 m (98 ft) deep, which seems to provide them with optimal foraging conditions for their generalized diet of small schooling fish and large, pelagic invertebrates: Pacific sand lance (*Ammodytes hexapterus*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea harengus*), surf smelt (*Hypomesus* sp.), euphausiids, mysids, amphipods, and other species (Nelson 1997, p. 7). However, they are assumed to be capable of diving to a depth of 47 m (157 ft) based on their body size and diving depths observed for other Alcid species (Mathews and Burger 1998, p. 71).

Contemporary studies of murrelet diets in the Puget Sound–Georgia Basin region indicate that Pacific sand lance now comprise the majority of the murrelet diet (Gutowsky et al. 2009, p. 251). Historically, energy-rich fishes such as herring and northern anchovy comprised the majority of the murrelet diet (Becker and Beissinger 2006, p. 470; Gutowsky et al. 2009, p. 247). This is significant because sandlance have the lowest energetic value of the fishes that murrelets commonly consume. For example, a single northern anchovy has nearly six times the energetic value of a sandlance of the same size (Gutowsky et al. 2009, p. 251), so a murrelet would have to eat six sandlance to get the equivalent energy of a single anchovy. Reductions in the abundance of energy-rich forage fish species is likely a contributing factor in the poor reproduction in murrelets (Becker and Beissinger 2006, p. 470).

The duration of dives appears to depend upon age (adults vs. juveniles), water depth, visibility, and depth and availability of prey. Dive duration has been observed ranging from 8 seconds to 115 seconds, although most dives are between 25 to 45 seconds (Day and Nigro 2000; Jodice and Collopy 1999; Thoresen 1989; Watanuki and Burger 1999). Diving bouts last over a period of 27 to 33 minutes (Nelson 1997, p. 9). They forage in deeper waters when upwelling, tidal rips, and daily activity of prey concentrate prey near the surface (Strachan et al. 1995). Murrelets are highly mobile and some make substantial changes in their foraging sites within the breeding season. For example, Becker and Beissinger (2003, p. 243) found that murrelets responded rapidly (within days or weeks) to small-scale variability in upwelling intensity and prey availability by shifting their foraging behavior and habitat selection within a 100-km (62-mile) area.

For more information on murrelet use of marine habitats, see literature reviews in McShane et al. 2004 and USFWS 2009.

<u>Murrelets in the Terrestrial Environment</u>

Murrelets are dependent upon older-age forests, or forests with an older tree component, for nesting habitat (Hamer and Nelson 1995, p. 69). Specifically, murrelets prefer high and broad platforms for landing and take-off, and surfaces which will support a nest cup (Hamer and Nelson 1995, pp. 78-79). In Washington, murrelet nests have been found in live conifers, specifically, western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), Douglas-fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*) (Hamer and Nelson 1995; Hamer

and Meekins 1999). Most murrelets appear to nest within 37 miles of the coast, although occupied behaviors have been recorded up to 52 miles inland, and murrelet presence has been detected up to 70 miles inland in Washington (Huff et al. 2006, p. 10). Nests occur primarily in large, older-aged trees. Overall, nests have been found in trees greater than 19 inches in diameter-at-breast and greater than 98 ft tall. Nesting platforms include limbs or other branch deformities that are greater than 4 inches in diameter, and are at greater than 33 ft above the ground. Substrate such as moss or needles on the nest platform is important for protecting the egg and preventing it from falling off (Huff et al. 2006, p. 13).

Murrelets do not form dense colonies which is atypical of most seabirds. Limited evidence suggests they may form loose colonies in some cases (Ralph et al. 1995). The reliance of murrelets on cryptic coloration to avoid detection suggests they utilize a wide spacing of nests in order to prevent predators from forming a search image (Ralph et al. 1995). Individual murrelets are suspected to have fidelity to nest sites or nesting areas, although this is has only been confirmed with marked birds in a few cases (Huff et al. 2006, p. 11). There are at least 15 records of murrelets using nest sites in the same or adjacent trees in successive years, but it is not clear if they were used by the same birds (McShane et al. 2004, p. 2-14). At the landscape scale, murrelets do show fidelity to foraging areas and probably to specific watersheds for nesting (McShane et al. 2004, p. 2-14). Murrelets have been observed visiting nesting habitat during non-breeding periods in Washington, Oregon, and California which may indicate adults are maintaining fidelity and familiarity with nesting sites and/or stands (Naslund 1993; O'Donnell et al. 1995, p. 125).

Loss of nesting habitat reduces nest site availability and displaces any murrelets that may have had nesting fidelity to the logged area (Raphael et al. 2002, p. 232). Murrelets have demonstrated fidelity to nesting stands and in some areas, fidelity to individual nest trees (Burger et al. 2009, p. 217). Murrelets returning to recently logged areas may not breed for several years or until they have found suitable nesting habitat elsewhere (Raphael et al. 2002, p. 232). The potential effects of displacement due to habitat loss include nest site abandonment, delayed breeding, failure to initiate breeding in subsequent years, and failed breeding due to increased predation risk at a marginal nesting location (Divoky and Horton 1995, p. 83; Raphael et al. 2002, p. 232). Each of these outcomes has the potential to reduce the nesting success for individual breeding pairs, and could ultimately result in the reduced recruitment of juvenile birds into the local population (Raphael et al. 2002, pp. 231-233).

Detailed information regarding the life history and conservation needs of the murrelet are presented in the *Ecology and Conservation of the Marbled Murrelet* (Ralph et al. 1995), the Service’s 1997 *Recovery Plan for the Marbled Murrelet* (USFWS 1997), and in subsequent 5-year status reviews (McShane et al. 2004; USFWS 2009).

Distribution

Murrelets are distributed along the Pacific coast of North America, with birds breeding from central California through Oregon, Washington, British Columbia, southern Alaska, westward through the Aleutian Island chain, with presumed breeding as far north as Bristol Bay (Nelson 1997, p. 2). The federally-listed murrelet population in Washington, Oregon, and California is

classified by the Service as a distinct population segment (75 FR 3424). The coterminous United States population of murrelets is considered significant as the loss of this distinct population segment would result in a significant gap in the range of the taxon and the loss of unique genetic characteristics that are significant to the taxon (75 FR 3430).

Murrelets spend most of their lives in the marine environment where they consume a diversity of prey species, including small fish and invertebrates. Murrelets occur primarily in nearshore marine waters within 5 km of the coast, but have been documented up to 300 km offshore in winter off the coast of Alaska (Nelson 1997, p. 3). The inland nesting distribution of murrelets is strongly associated with the presence of mature and old-growth conifer forests. Murrelets have been detected >100 km inland in Washington (70 miles), while the inland distribution in the southern portion of the species range is associated with the extent of the hemlock/tanoak vegetation zone which occurs up to 16-51 km inland (10-32 miles) (Evans Mack et al. 2003, p. 4).

The distribution of murrelets in marine waters during the summer breeding season is highly variable along the Pacific coast, with areas of high density occurring along the Strait of Juan de Fuca in Washington, the central Oregon coast, and northern California (Raphael et al. 2015c, p. 20). Low-density areas or gaps in murrelet distribution occur in central California, and along the southern Washington coast (Raphael et al. 2015c, p. 21). Analysis of various marine and terrestrial habitat factors indicate that the amount and configuration of inland nesting habitat is the strongest factor that influences the marine distribution of murrelets during the nesting season (Raphael et al. 2015c, p. 17). Local aggregations or "hot spots" of murrelets in nearshore marine waters are strongly associated with landscapes that support large, contiguous areas of mature and old-growth forest.

Distribution of Nesting Habitat

The loss of nesting habitat was a major cause of the murrelets decline over the past century and may still be contributing as nesting habitat continues to be lost to fires, logging, and wind storms (Miller et al. 2012, p. 778). Due mostly to historic timber harvest, only a small percentage (~11 percent) of the habitat-capable lands within the listed range of the murrelet currently contain potential nesting habitat (Raphael et al. 2015b, p. 118). Monitoring of murrelet nesting habitat within the Northwest Forest Plan area indicates nesting habitat declined from an estimated 2.53 million acres in 1993 to an estimated 2.23 million acres in 2012, a decline of about 12.1 percent (Raphael et al. 2015b, p. 89). Fire has been the major cause of nesting habitat loss on Federal lands, while timber harvest is the primary cause of loss on non-Federal lands (Raphael et al. 2015b, p. 90). While most (60 percent) of the potential habitat is located on Federal reserved-land allocations, a substantial amount of nesting habitat occurs on non-federal lands (34 percent) (Table 1).

Table 1. Estimates of higher-quality murrelet nesting habitat by State and major land ownership within the area of the Northwest Forest Plan – derived from 2012 data.

State	Habitat capable lands (1,000s of acres)	Habitat on Federal reserved lands (1,000s of acres)	Habitat on Federal non-reserved lands (1,000s of acres)	Habitat on non-federal lands (1,000s of acres)	Total potential nesting habitat (all lands) (1,000s of acres)	Percent of habitat capable land that is currently in habitat
WA	10,851.1	822.4	64.7	456	1,343.1	12 %
OR	6,610.4	484.5	69.2	221.1	774.8	12 %
CA	3,250.1	24.5	1.5	82.9	108.9	3 %
Totals	20,711.6	1,331.4	135.4	760	2,226.8	11 %
Percent		60 %	6 %	34 %	100 %	-

Source: (Raphael et al. 2015b, pp. 115-118)

Population Status

The 1997 *Recovery Plan for the Marbled Murrelet* (USFWS 1997) identified six Conservation Zones throughout the listed range of the species: Puget Sound (Conservation Zone 1), Western Washington Coast Range (Conservation Zone 2), Oregon Coast Range (Conservation Zone 3), Siskiyou Coast Range (Conservation Zone 4), Mendocino (Conservation Zone 5), and Santa Cruz Mountains (Conservation Zone 6) (Figure 1). Recovery zones are the functional equivalent of recovery units as defined by Service policy (USFWS 1997, p. 115). The subpopulations in each Zone are not discrete. There is some movement of murrelets between Zones as indicated by radio-telemetry studies (e.g., Bloxton and Raphael 2006, p. 162), but the degree to which murrelets migrate between Zones is unknown. For the purposes of consultation, the Service treats each of the Conservation Zones as separate sub-populations of the listed murrelet population.

Population Status and Trends

Population estimates for the murrelet are derived from marine surveys conducted during the nesting season as part of the Northwest Forest Plan effectiveness monitoring program. Surveys from 2001 to 2013 indicated that the murrelet population in Conservation Zones 1 through 5 (Northwest Forest Plan area) declined at a rate of -1.2 percent per year (Falxa et al. 2015, pp. 7-8). While the overall trend estimate across this time period is negative, the evidence of a detectable linear decline is not conclusive because the confidence intervals for the estimated trend overlap zero (95% confidence interval [CI]:-2.9 to 0.5 percent) (Falxa et al. 2015, pp. 7-8) (Table 2). This differs from the declines previously reported at the Northwest Forest Plan-scale for the 2001 to 2010 period. This difference was the result of high population estimates for 2011 through 2013 compared to the previous several years, which reduced the slope of the trend and increased variability (Falxa and Raphael 2015, p. 4).

Population monitoring from 2001 to 2013 indicates strong evidence for a linear decline for murrelet subpopulations in Washington, while trends in Oregon and northern California indicate potentially stable or increasing subpopulations with no conclusive evidence of a positive or negative trend over the monitoring period (Falxa et al. 2015, p. 26). While the direct causes for subpopulation declines in Washington are unknown, potential factors include the loss of nesting habitat, including cumulative and time-lag effects of habitat losses over the past 20 years (an individual murrelets potential lifespan), changes in the marine environment reducing the availability or quality of prey, increased densities of nest predators, and emigration (Miller et al. 2012, p. 778).

The most recent population estimate for the entire Northwest Forest Plan area in 2013 was 19,700 murrelets (95 percent CI: 15,400 to 23,900 birds) (Falxa et al. 2015, p. 7). The largest and most stable murrelet subpopulations now occur off the Oregon and northern California coasts, while subpopulations in Washington have experienced the greatest rates of decline. Murrelet zones are now surveyed on an every other-year basis, so the last year that a range-wide estimate for all zones combined is 2013 (Table 2). Subsequent surveys in Washington, Oregon, and California have been completed during the 2014 and 2015 seasons. Summaries of these more recent surveys are presented in Table 3.

The murrelet subpopulation in Conservation Zone 6 (central California- Santa Cruz Mountains) is outside of the Northwest Forest Plan area and is monitored separately by the University of California as part of an oil-spill compensation program (Henry et al. 2012, p. 2). Surveys in Zone 6 indicate a small subpopulation of murrelets with no clear trends. Population estimates from 2001 to 2014 have fluctuated from a high of 699 murrelets in 2003, to a low of 174 murrelets in 2008 (Henry and Tyler 2014, p. 3). In 2014, surveys indicated an estimated population of 437 murrelets in Zone 6 (95% CI: 306-622) (Henry and Tyler 2014, p. 3) (Table 3).

Table 2. Summary of murrelet population estimates and trends (2001-2013) at the scale of Conservation Zones and States (estimates combined across Zones within the Northwest Forest Plan area).

Zone	Year	Estimated number of murrelets	95% CI Lower	95% CI Upper	Average density (at sea) (murrelets /km^2)	Average annual rate of change (%)	95% CI Lower	95% CI Upper	Cumulative change over 10 years (%)
1	2013	4,395	2,298	6,954	1.26	-3.9	-7.6	0.0	-32.8
2	2013	1,271	950	1,858	0.77	-6.7	-11.4	-1.8	-50.0
3	2013	8,841	6,819	11,276	5.54	+1.3	-1.1	+3.8	+6.2
4	2013	6,046	4,531	9,282	5.22	+1.5	-0.9	+4.0	+16.1
5	2013	71	5	118	0.08	-1.0	-8.3	+6.9	-9.6
Zones 1-5	2013	19,662	15,398	23,927	2.24	-1.2	-2.9	+0.5	-11.3
Zone 6	2013	628	386	1,022	na	na	na	na	na
WA	2013	5,665	3,217	8,114	1.10	-5.1	-7.7	-2.5	-37.6
OR	2013	9,819	6,158	13,480	4.74	0.3	-1.8	2.5	+3.0
CA	2013	4,178	3,561	4,795	2.67	2.5	-1.1	6.2	+28.0

Sources: (Falxa et al. 2015, pp. 41-43; Henry and Tyler 2014, p. 3).

Table 3. Summary of the most recent murrelet population estimates by Zone (2014-2015).

Zone	Year	Estimated number of murrelets	Estimated population 95% CI Lower	Estimated population 95% CI Upper	Average annual rate of decline (2001-2015)
1	2015	4,290	2,783	6,492	-5.3 %
2	2015	3,204	1,883	5,609	-2.8 %
3	2014	8,841	6,819	11,276	nc
4	2015	8,743	7,409	13,125	nc
5	2013	71	5	118	nc
6	2014	437	306	622	nc

Sources: (Henry and Tyler 2014, p. 3; Lance and Pearson 2016, pp. 4-5; NWFPEMP 2016, pp. 2-3).

Factors Influencing Population Trends

Murrelet populations are declining in Washington, stable in Oregon, and stable in California where there is a non-significant but positive population trend (Raphael et al. 2015a, p. 163). Murrelet population size and distribution is strongly and positively correlated with the amount and pattern (large contiguous patches) of suitable nesting habitat and population trend is most strongly correlated with trend in nesting habitat although marine factors also contribute to this trend (Raphael et al. 2015a, p. 156). From 1993 to 2012, there was a net loss of about 2 percent of potential nesting habitat from on federal lands, compared to a net loss of about 27 percent on nonfederal lands, for a total cumulative net loss of about 12.1 percent across the Northwest Forest Plan area (Raphael et al. 2015b, p. 66). Cumulative habitat losses since 1993 have been greatest in Washington, with most habitat loss in Washington occurring on non-Federal lands due to timber harvest (Raphael et al. 2015b, p. 124) (Table 4).

Table 4. Distribution of higher-suitability murrelet nesting habitat by Conservation Zone, and summary of net habitat changes from 1993 to 2012 within the Northwest Forest Plan area.

Conservation Zone	**1993**	**2012**	**Change (acres)**	**Change (percent)**
Zone 1 - Puget Sound/Strait of Juan de Fuca	829,525	739,407	-90,118	-10.9 %
Zone 2 - Washington Coast	719,414	603,777	-115,638	-16.1 %
Zone 3 - Northern to central Oregon	662,767	610,583	-52,184	-7.9 %
Zone 4 - Southern Oregon - northern California	309,072	256,636	-52,436	-17 %
Zone 5 - north-central California	14,060	16,479	+2,419	+17.2 %

Source: (Raphael et al. 2015b, p. 121).

The decline in murrelet populations from 2001 to 2013 is weakly correlated with the decline in nesting habitat, with the greatest declines in Washington, and the smallest declines in California, indicating that when nesting habitat decreases, murrelet abundance in adjacent marine waters may also decrease. At the scale of Conservation Zones, the strongest correlation between habitat loss and murrelet decline is in Zone 2, the zone where both murrelet habitat and murrelet abundance has declined the greatest. However these relationships are not linear, and there is much unexplained variation (Raphael et al. 2015a, p. 163). While terrestrial habitat amount and configuration (i.e., fragmentation) and the terrestrial human footprint (i.e., cities, roads, development) appear to be strong factors influencing murrelet distribution in Zones 2-5; terrestrial habitat and the marine human footprint (i.e., shipping lanes, boat traffic, shoreline development) appear to be the most important factors that influence the marine distribution and abundance of murrelets in Zone 1 (Raphael et al. 2015a, p. 163).

As a marine bird, murrelet survival is dependent on their ability to successfully forage in the marine environment. Despite this, it is apparent that the location, amount, and landscape pattern of terrestrial nesting habitat are strongest predictors of the spatial and temporal distributions of

murrelets at sea during the nesting season (Raphael et al. 2015c, p. 20). Various marine habitat features (e.g., shoreline type, depth, temperature, etc.) apparently have only a minor influence on murrelet distribution at sea. Despite this relatively weak spatial relationship, marine factors, and especially any decrease in forage species, likely play an important role in explaining the apparent population declines, but the ability to model these relationships is currently limited (Raphael et al. 2015c, p. 20).

Population Models

Prior to the use of survey data to estimate trend, demographic models were more heavily relied upon to generate predictions of trends and extinction probabilities for the murrelet population (Beissinger 1995; Cam et al. 2003; McShane et al. 2004; USFWS 1997). However, murrelet population models remain useful because they provide insights into the demographic parameters and environmental factors that govern population stability and future extinction risk, including stochastic factors that may alter survival, reproductive, and immigration/emigration rates.

In a report developed for the *5-year Status Review of the Marbled Murrelet in Washington, Oregon, and California* (McShane et al. 2004, p. 3-27 to 3-60), models were used to forecast 40-year murrelet population trends. A series of female-only, multi-aged, discrete-time stochastic Leslie Matrix population models were developed for each conservation zone to forecast decadal population trends over a 40-year period with extinction probabilities beyond 40 years (to 2100). The authors incorporated available demographic parameters (Table 5) for each conservation zone to describe population trends and evaluate extinction probabilities (McShane et al. 2004, p. 3-49).

McShane et al. (2004) used mark-recapture studies conducted in British Columbia by Cam et al. (2003) and Bradley et al. (2004) to estimate annual adult survival and telemetry studies or at-sea survey data to estimate fecundity. Model outputs predicted -3.1 to -4.6 percent mean annual rates of population change (decline) per decade the first 20 years of model simulations in murrelet Conservation Zones 1 through 5 (McShane et al. 2004, p. 3-52). Simulations for all zone populations predicted declines during the 20 to 40-year forecast, with mean annual rates of -2.1 to -6.2 percent per decade (McShane et al. 2004, p. 3-52). While these modeled rates of decline are similar to those observed in Washington (Falxa and Raphael 2015, p. 4), the simulated projections at the scale of Zones 1-5 do not match the potentially stable or increasing populations observed in Oregon and California during the 2001-2013 monitoring period.

Table 5. Rangewide murrelet demographic parameter values based on four studies all using Leslie Matrix models.

Demographic Parameter	**Beissinger 1995**	**Beissinger and Nur 1997***	**Beissinger and Peery (2007)**	**McShane et al. 2004**
Juvenile Ratio (Ŕ)	0.10367	0.124 or 0.131	0.089	0.02 - 0.09
Annual Fecundity	0.11848	0.124 or 0.131	0.06-0.12	-
Nest Success	-	-	0.16-0.43	0.38 - 0.54
Maturation	3	3	3	2 - 5
Estimated Adult Survivorship	85 % – 90%	85 % – 88 %	82 % - 90 %	83 % – 92 %

*In U.S. Fish and Wildlife (1997).

Reproduction

Generally, estimates of murrelet fecundity are directed at measures of breeding success, either from direct assessments of nest success in the terrestrial environment, marine counts of hatch-year birds, or computer models. Telemetry estimates are typically preferred over marine counts for estimating breeding success due to fewer biases (McShane et al. 2004, p. 3-2). However, because of the challenges of conducting telemetry studies, estimating murrelet reproductive rates with an index of reproduction, referred to as the juvenile ratio (Ŕ),[1] continues to be important, despite the debate over use of this index (see discussion in Beissinger and Peery 2007, p. 296).

Although difficult to obtain, nest success rates[2] are available from telemetry studies conducted in California (Hebert and Golightly 2006; Peery et al. 2004) and Washington (Bloxton and Raphael 2006). In northwest Washington, Bloxton and Raphael (2005, p. 5) documented a nest success rate of 0.20 (2 chicks fledging from 10 nest starts). In central California, murrelet nest success is 0.16 (Peery et al. 2004, p. 1098) and in northern California it is 0.31 to 0.56 (Hebert and Golightly 2006, p. 95). No studies or published reports from Oregon are available.

Unadjusted and adjusted values for estimates of murrelet juvenile ratios suggest extremely low breeding success in northern California (0.003 to 0.008 - Long et al. 2008, pp. 18-19), central California (0.035 and 0.032 - Beissinger and Peery 2007, pp. 299, 302), and in Oregon (0.0254 - 0.0598 - Crescent Coastal Research 2008, p. 13). Estimates for **Ŕ** (adjusted) in the San Juan Islands in Washington have been below 0.15 every year since surveys began in 1995, with three of those years below 0.05 (Raphael et al. 2007, p. 16).

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1 The juvenile ratio (**Ŕ**) for murrelets is derived from the relative abundance of hatch-year (HY; 0-1 yr-old) to after-hatch-year (AHY; 1+ yr-old) birds (Beissinger and Peery 2007, p. 297) and is calculated from marine survey data.

2 Nest success here is defined by the annual number of known hatchlings departing from the nest (fledging) divided by the number of nest starts.

These estimates of **Ŕ** are assumed to be below the level necessary to maintain or increase the murrelet population. Demographic modeling suggests murrelet population stability requires a minimum reproductive rate of 0.18 to 0.28 (95 % CI) chicks per pair per year (Beissinger and Peery 2007, p. 302; USFWS 1997). Even the lower levels of the 95 percent confidence interval from USFWS (1997) and Beissinger and Peery (2007, p. 302) is greater than the current range of estimates for Ŕ (0.02 to 0.13 chicks per pair) for any of the Conservation Zones (Table 4).

The current estimates for **Ŕ** also appear to be well below what may have occurred prior to the murrelet population decline. Beissinger and Peery (2007, p. 298) performed a comparative analysis using historic data from 29 bird species to predict the historic **Ŕ** for murrelets in central California, resulting in an estimate of 0.27 (95% CI: 0.15 - 0.65). Therefore, the best available scientific information of murrelet fecundity from model predictions and trend analyses of survey-derived population data appear to align well. Both indicate that the murrelet reproductive rate is generally insufficient to maintain stable population numbers throughout all or portions of the species' listed range.

<u>Summary: Murrelet Abundance, Distribution, Trend, and Reproduction</u>

Although murrelets are distributed throughout their historical range, the area of occupancy within their historic range appears to be reduced from historic levels. The distribution of the species also exhibits five areas of discontinuity: a segment of the border region between British Columbia, Canada and Washington; southern Puget Sound, WA; Destruction Island, WA to Tillamook Head, OR; Humboldt County, CA to Half Moon Bay, CA; and the entire southern end of the breeding range in the vicinity of Santa Cruz and Monterey Counties, CA (McShane et al. 2004, p. 3-70).

A statistically significant decline was detected in Conservation Zones 1 and 2 for the 2001-2014 period (Table 2). The overall population trend from the combined 2001-2013 population estimates (Conservation Zones 1 - 5) indicate a decline at a rate of -1.2 percent per year (Falxa et al. 2015, pp. 7-8). This decline across the listed range is most influenced by the significant declines in Washington, while subpopulations in Oregon and California are potentially stable.

The current range of estimates for **Ŕ**, the juvenile to adult ratio, is assumed to be below the level necessary to maintain or increase the murrelet population. Whether derived from marine surveys or from population modeling (**Ŕ** = 0.02 to 0.13, Table 4), the available information is in general agreement that the current ratio of hatch-year birds to after-hatch year birds is insufficient to maintain stable numbers of murrelets throughout the listed range. The current estimates for **Ŕ** also appear to be well below what may have occurred prior to the murrelet population decline (Beissinger and Peery 2007, p. 298).

Considering the best available data on abundance, distribution, population trend, and the low reproductive success of the species, the Service concludes the murrelet population within the Washington portion of its listed range currently has little or no capability to self-regulate, as indicated by the significant, annual decline in abundance the species is currently undergoing in Conservation Zones 1 and 2. Populations in Oregon and California are apparently more stable, but threats associated with habitat loss and habitat fragmentation continue to occur in those

areas. The Service expects the species to continue to exhibit further reductions in the distribution and abundance into the foreseeable future, due largely to the expectation that the variety of environmental stressors present in the marine and terrestrial environments (discussed in the *Threats to Murrelet Survival and Recovery* section) will continue into the foreseeable future.

Threats to Murrelet Survival and Recovery

When the murrelet was listed under the Endangered Species Act in 1992, several anthropogenic threats were identified as having caused the dramatic decline in the species:

- habitat destruction and modification in the terrestrial environment from timber harvest and human development caused a severe reduction in the amount of nesting habitat
- unnaturally high levels of predation resulting from forest "edge effects" ;
- the existing regulatory mechanisms, such as land management plans (in 1992), were considered inadequate to ensure protection of the remaining nesting habitat and reestablishment of future nesting habitat; and
- manmade factors such as mortality from oil spills and entanglement in fishing nets used in gill-net fisheries.

The regulatory mechanisms implemented since 1992 that affect land management in Washington, Oregon, and California (for example, the Northwest Forest Plan) and new gill-netting regulations in northern California and Washington have reduced the threats to murrelets (USFWS 2004, pp. 11-12). However, additional threats were identified in the Service's 2009, 5-year review for the murrelet (USFWS 2009, pp. 27-67). These stressors are due to several environmental factors affecting murrelets in the marine environment. These stressors include:

- Habitat destruction, modification, or curtailment of the marine environmental conditions necessary to support murrelets due to:
    - elevated levels of polychlorinated biphenyls in murrelet prey species;
    - changes in prey abundance and availability;
    - changes in prey quality;
    - harmful algal blooms that produce biotoxins leading to domoic acid and paralytic shellfish poisoning that have caused murrelet mortality; and
    - climate change in the Pacific Northwest.

- Manmade factors that affect the continued existence of the species include:
    - derelict fishing gear leading to mortality from entanglement;
    - disturbance in the marine environment (from exposures to lethal and sub-lethal levels of high underwater sound pressures caused by pile-driving, underwater detonations, and potential disturbance from high vessel traffic).

Since the time of listing, the murrelet population has continued to decline due to lack of successful reproduction and recruitment. The murrelet Recovery Implementation Team identified five major mechanisms that appear to be contributing to this decline (USFWS 2012b, pp. 10-11):

- Ongoing and historic loss of nesting habitat.
- Predation on murrelet eggs and chicks in their nests.
- Changes in marine conditions, affecting the abundance, distribution, and quality of murrelet prey species.
- Post-fledging mortality (predation, gill-nets, oil-spills).
- Cumulative and interactive effects of factors on individuals and populations.

Climate Change

In the Pacific Northwest, mean annual temperatures rose 0.8° C (1.5° F) in the 20th century and are expected to continue to warm from 0.1° to 0.6° C (0.2° to 1° F) per decade (Mote and Salathe 2010, p. 29). Climate change models generally predict warmer, wetter winters and hotter, drier summers and increased frequency of extreme weather events in the Pacific Northwest (Salathé et al. 2010, pp. 72-73). Predicted climate changes in the Pacific Northwest have implications for forest disturbances that affect the quality and distribution of murrelet habitat. Both the frequency and intensity of wildfires and insect outbreaks are expected to increase over the next century in the Pacific Northwest (Littell et al. 2010, p. 130).

One of the largest projected effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration, and severity. Westerling et al. (2006, pp. 940-941) analyzed wildfires and found that since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period from 1970-1986. The total area burned is more than 6.5 times the previous level and the average length of the fire season during 1987-2003 was 78 days longer compared to 1978-1986 (Westerling et al. 2006, p. 941). The area burned annually by wildfires in the Pacific Northwest is expected to double or triple by the 2080s (Littell et al. 2010, p. 140). Wildfires are now the primary cause of murrelet habitat loss on Federal lands, with over 21,000 acres of habitat loss attributed to wildfires from 1993 to 2012 (Raphael et al. 2015b, p. 123). Climate change is likely to further exacerbate some existing threats such as the projected potential for increased habitat loss from drought related fire, mortality, insects and disease, and increases in extreme flooding, landslides and windthrow events in the short-term (10 to 30 years).

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Within the marine environment, effects on the murrelet food supply (amount, distribution, quality) provide the most likely mechanism for climate change impacts to murrelets. Studies in British Columbia (Norris et al. 2007) and California (Becker and Beissinger 2006) have documented long-term declines in the quality of murrelet prey, and one of these studies (Becker and Beissinger 2006, p. 475) linked variation in coastal water temperatures, murrelet prey quality during pre-breeding, and murrelet reproductive success. These studies indicate that murrelet recovery may be affected as long-term trends in ocean climate conditions affect prey resources

and murrelet reproductive rates. While seabirds such as the murrelet have life-history strategies adapted to variable marine environments, ongoing and future climate change could present changes of a rapidity and scope outside the adaptive range of murrelets (USFWS 2009, p. 46).

Conservation Needs of the Species

Reestablishing an abundant supply of high quality murrelet nesting habitat is a vital conservation need given the extensive removal during the 20th century. However, there are other conservation imperatives. Foremost among the conservation needs are those in the marine and terrestrial environments to increase murrelet fecundity by increasing the number of breeding adults, improving murrelet nest success (due to low nestling survival and low fledging rates), and reducing anthropogenic stressors that reduce individual fitness or lead to mortality.

The overall reproductive success (fecundity) of murrelets is directly influenced by nest predation rates (reducing nestling survival rates) in the terrestrial environment and an abundant supply of high quality prey in the marine environment during the breeding season (improving potential nestling survival and fledging rates). Anthropogenic stressors affecting murrelet fitness and survival in the marine environment are associated with commercial and tribal gillnets, derelict fishing gear, oil spills, and high underwater sound pressure (energy) levels generated by pile-driving and underwater detonations (that can be lethal or reduce individual fitness).

General criteria for murrelet recovery (delisting) were established at the inception of the Plan and they have not been met. More specific delisting criteria are expected in the future to address population, demographic, and habitat based recovery criteria (USFWS 1997, p. 114-115). The general criteria include:

- documenting stable or increasing population trends in population size, density, and productivity in four of the six Conservation Zones for a 10-year period and
- implementing management and monitoring strategies in the marine and terrestrial environments to ensure protection of murrelets for at least 50 years.

Thus, increasing murrelet reproductive success and reducing the frequency, magnitude, or duration of any anthropogenic stressor that directly or indirectly affects murrelet fitness or survival in the marine and terrestrial environments are the priority conservation needs of the species. The Service estimates recovery of the murrelet will require at least 50 years (USFWS 1997)

Recovery Plan

The Marbled Murrelet Recovery Plan outlines the conservation strategy with both short- and long-term objectives. The Plan places special emphasis on the terrestrial environment for habitat-based recovery actions due to nesting occurring in inland forests.

In the short-term, specific actions identified as necessary to stabilize the populations include protecting occupied habitat and minimizing the loss of unoccupied but suitable habitat (USFWS 1997, p. 119). Specific actions include maintaining large blocks of suitable habitat, maintaining

and enhancing buffer habitat, decreasing risks of nesting habitat loss due to fire and windthrow, reducing predation, and minimizing disturbance. The designation of critical habitat also contributes towards the initial objective of stabilizing the population size through the maintenance and protection of occupied habitat and minimizing the loss of unoccupied but suitable habitat.

Long-term conservation needs identified in the Plan include:

- increasing productivity (abundance, the ratio of juveniles to adults, and nest success) and population size;
- increasing the amount (stand size and number of stands), quality, and distribution of suitable nesting habitat;
- protecting and improving the quality of the marine environment; and
- reducing or eliminating threats to survivorship by reducing predation in the terrestrial environment and anthropogenic sources of mortality at sea.

Recovery Zones in Washington

Conservation Zones 1 and 2 extend inland 50 miles from marine waters. Conservation Zone 1 includes all the waters of Puget Sound and most waters of the Strait of Juan de Fuca south of the U.S.-Canadian border and the Puget Sound, including the north Cascade Mountains and the northern and eastern sections of the Olympic Peninsula. Conservation Zone 2 includes marine waters within 1.2 miles (2 km) off the Pacific Ocean shoreline, with the northern terminus immediately south of the U.S.-Canadian border near Cape Flattery along the midpoint of the Olympic Peninsula and extending to the southern border of Washington (the Columbia River) (USFWS 1997, pg. 126).

Lands considered essential for the recovery of the murrelet within Conservation Zones 1 and 2 are 1) any suitable habitat in a Late Successional Reserve (LSR), 2) all suitable habitat located in the Olympic Adaptive Management Area, 3) large areas of suitable nesting habitat outside of LSRs on Federal lands, such as habitat located in the Olympic National Park, 4) suitable habitat on State lands within 40 miles off the coast, and 5) habitat within occupied murrelet sites on private lands (USFWS 1997).

Summary

At the range-wide scale, murrelet populations have declined at an average rate of 1.2 percent per year since 2001. The most recent population estimate for the entire Northwest Forest Plan area in 2013 was 19,700 murrelets (95 percent CI: 15,400 to 23,900 birds) (Falxa et al. 2015, p. 7). The largest and most stable murrelet subpopulations now occur off the Oregon and northern California coasts, while subpopulations in Washington have experienced the greatest rates of decline (-4.4 percent per year; 95% CI: -6.8 to -1.9%) (Lance and Pearson 2016, p. 5).

Monitoring of murrelet nesting habitat within the Northwest Forest Plan area indicates nesting habitat declined from an estimated 2.53 million acres in 1993 to an estimated 2.23 million acres in 2012, a decline of about 12.1 percent (Raphael et al. 2015b, p. 89). Murrelet population size is strongly and positively correlated with amount of nesting habitat, suggesting that conservation of remaining nesting habitat and restoration of currently unsuitable habitat is key to murrelet recovery (Raphael et al. 2011, p. iii).

The species decline has been largely caused by extensive removal of late-successional and old growth coastal forest which serves as nesting habitat for murrelets. Additional factors in its decline include high nest-site predation rates and human-induced mortality in the marine environment from disturbance, gillnets, and oil spills. In addition, murrelet reproductive success is strongly correlated with the abundance of marine prey species. Overfishing and oceanographic variation from climate events have likely altered both the quality and quantity of murrelet prey species (USFWS 2009, p. 67).

Although some threats have been reduced, most continue unabated and new threats now strain the ability of the murrelet to successfully reproduce. Threats continue to contribute to murrelet population declines through adult and juvenile mortality and reduced reproduction. Therefore, given the current status of the species and background risks facing the species, it is reasonable to assume that murrelet populations in Conservation Zones 1 and 2 and throughout the listed range have low resilience to deleterious population-level effects and are at high risk of continual declines. Activities which degrade the existing conditions of occupied nest habitat or reduce adult survivorship and/or nest success of murrelets will be of greatest consequence to the species. Actions resulting in the further loss of occupied nesting habitat, mortality to breeding adults, eggs, or nestlings will reinforce the current murrelet population decline throughout the coterminous United States.

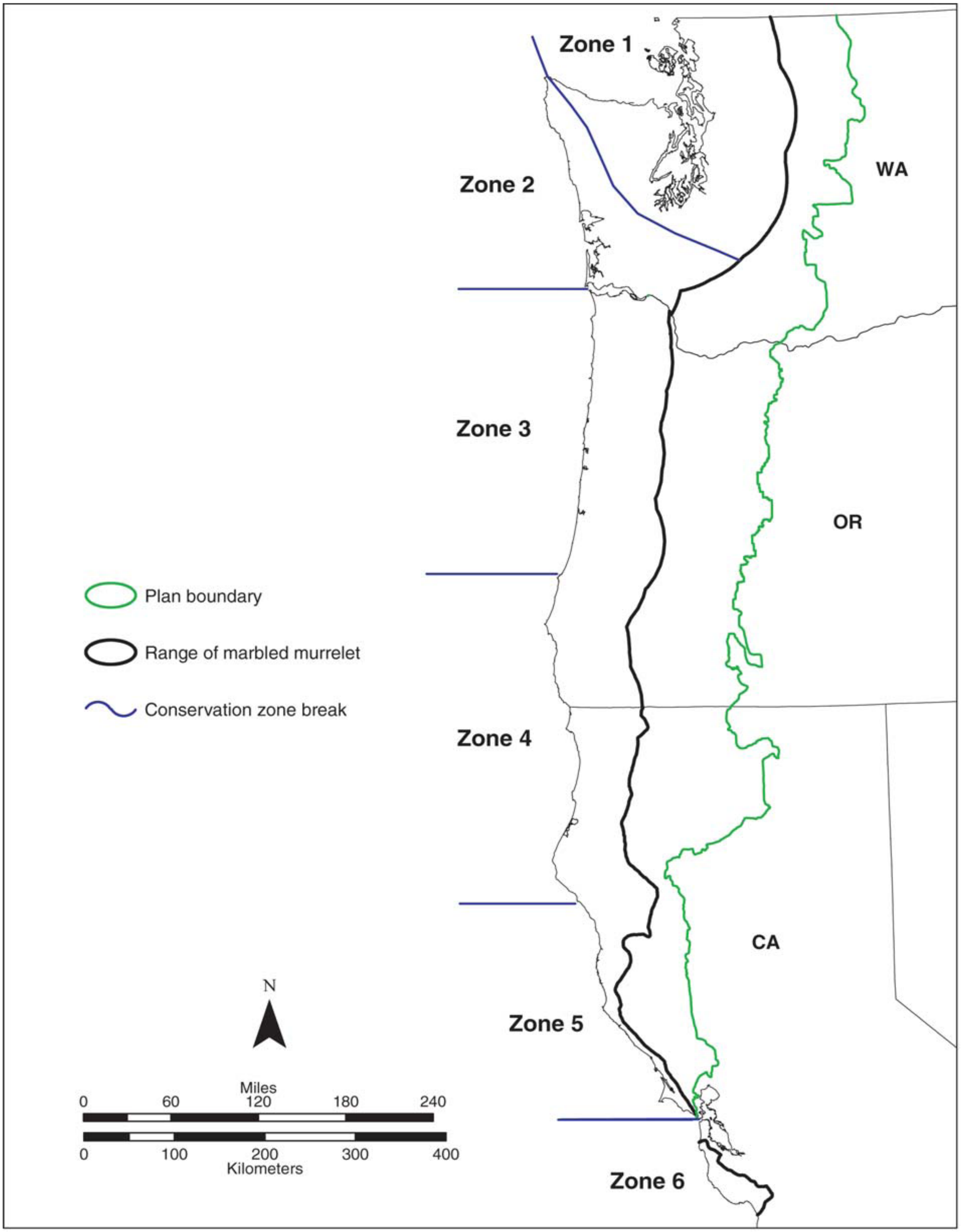

Figure 1. The six geographic areas identified as Conservation Zones in the recovery plan for the marbled murrelet (USFWS 1997). Note: "Plan boundary" refers to the Northwest Forest Plan. Figure adapted from Huff et al. (2006, p. 6).

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APPENDIX D: STATUS OF THE SPECIES: BULL TROUT

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Appendix D
Status of Species: Bull Trout

Taxonomy

The bull trout (*Salvelinus confluentus*) is a native char found in the coastal and intermountain west of North America. Dolly Varden (*Salvelinus malma)* and bull trout were previously considered a single species and were thought to have coastal and interior forms. However, Cavender (1978, entire) described morphometric, meristic and osteological characteristics of the two forms, and provided evidence of specific distinctions between the two. Despite an overlap in the geographic range of bull trout and Dolly Varden in the Puget Sound area and along the British Columbia coast, there is little evidence of introgression (Haas and McPhail 1991, p. 2191). The Columbia River Basin is considered the region of origin for the bull trout. From the Columbia, dispersal to other drainage systems was accomplished by marine migration and headwater stream capture. Behnke (2002, p. 297) postulated dispersion to drainages east of the continental divide may have occurred through the North and South Saskatchewan Rivers (Hudson Bay drainage) and the Yukon River system. Marine dispersal may have occurred from Puget Sound north to the Fraser, Skeena and Taku Rivers of British Columbia.

Species Description

Bull trout have unusually large heads and mouths for salmonids. Their body colors can vary tremendously depending on their environment, but are often brownish green with lighter (often ranging from pale yellow to crimson) colored spots running along their dorsa and flanks, with spots being absent on the dorsal fin, and light colored to white under bellies. They have white leading edges on their fins, as do other species of char. Bull trout have been measured as large as 103 centimeters (41 inches) in length, with weights as high as 14.5 kilograms (32 pounds) (Fishbase 2015, p. 1). Bull trout may be migratory, moving throughout large river systems, lakes, and even the ocean in coastal populations, or they may be resident, remaining in the same stream their entire lives (Rieman and McIntyre 1993, p. 2; Brenkman and Corbett 2005, p. 1077). Migratory bull trout are typically larger than resident bull trout (USFWS 1998, p. 31668).

Legal Status

The coterminous United States population of the bull trout was listed as threatened on November 1, 1999 (USFWS 1999, entire). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Bond 1992, p. 4; Brewin and Brewin 1997, pp. 209-216; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 715-720).

Throughout its range, the 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, entrainment (a process by which aquatic organisms are pulled

through a diversion or other device) into diversion channels, and introduced non-native species (USFWS 1999, p. 58910). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007, entire; Rieman et al. 2007, entire; Porter and Nelitz. 2009, pages 4-8). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

Life History

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989, p. 30; Pratt 1985, pp. 28-34). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982, p. 95).

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989, p. 141). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, pp. 15-16; Pratt 1992, pp. 6-7; Rieman and McIntyre 1996, p. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 1). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, p. 1; Ratliff and Howell 1992, p. 10).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002, p. 9) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007, p. 10). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are

interrelated variables that affect the survival of incubating embryos (ODEQ 1995, Ch 2 pp. 23-24). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Population Dymanics

Population Structure

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993, p. 2). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Goetz 1989, p. 15). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, p. 138; Goetz 1989, p. 24), or saltwater (anadromous form) to rear as subadults and to live as adults (Brenkman and Corbett 2005, entire; McPhail and Baxter 1996, p. i; WDFW et al. 1997, p. 16). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, p. 135; Leathe and Graham 1982, p. 95; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133).

Bull trout are naturally migratory, which allows them to capitalize on temporally abundant food resources and larger downstream habitats. Resident forms may develop where barriers (either natural or manmade) occur or where foraging, migrating, or overwintering habitats for migratory fish are minimized (Brenkman and Corbett 2005, pp. 1075-1076; Goetz et al. 2004, p. 105). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002, pp. 96, 98-106). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 861-863; MBTSG 1998, p. 13; Rieman and McIntyre 1993, pp. 2-3). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993, p. 2).

Whitesel et al. (2004, p. 2) noted that although there are multiple resources that contribute to the subject, Spruell et al. (2003, entire) best summarized genetic information on bull trout population structure. Spruell et al. (2003, entire) analyzed 1,847 bull trout from 65 sampling locations, four located in three coastal drainages (Klamath, Queets, and Skagit Rivers), one in the Saskatchewan

River drainage (Belly River), and 60 scattered throughout the Columbia River Basin. They concluded that there is a consistent pattern among genetic studies of bull trout, regardless of whether examining allozymes, mitochondrial DNA, or most recently microsatellite loci. Typically, the genetic pattern shows relatively little genetic variation within populations, but substantial divergence among populations. Microsatellite loci analysis supports the existence of at least three major genetically differentiated groups (or evolutionary lineages) of bull trout (Spruell et al. 2003, p. 17). They were characterized as:

i. "Coastal", including the Deschutes River and all of the Columbia River drainage downstream, as well as most coastal streams in Washington, Oregon, and British Columbia. A compelling case also exists that the Klamath Basin represents a unique evolutionary lineage within the coastal group.

ii. "Snake River", which also included the John Day, Umatilla, and Walla Walla rivers. Despite close proximity of the John Day and Deschutes Rivers, a striking level of divergence between bull trout in these two systems was observed.

iii. "Upper Columbia River" which includes the entire basin in Montana and northern Idaho. A tentative assignment was made by Spruell et al. (2003, p. 25) of the Saskatchewan River drainage populations (east of the continental divide), grouping them with the upper Columbia River group.

Spruell et al. (2003, p. 17) noted that within the major assemblages, populations were further subdivided, primarily at the level of major river basins. Taylor et al. (1999, entire) surveyed bull trout populations, primarily from Canada, and found a major divergence between inland and coastal populations. Costello et al. (2003, p. 328) suggested the patterns reflected the existence of two glacial refugia, consistent with the conclusions of Spruell et al. (2003, p. 26) and the biogeographic analysis of Haas and McPhail (2001, entire). Both Taylor et al. (1999, p. 1166) and Spruell et al. (2003, p. 21) concluded that the Deschutes River represented the most upstream limit of the coastal lineage in the Columbia River Basin.

More recently, the U.S. Fish and Wildlife Service (Service) identified additional genetic units within the coastal and interior lineages (Ardren et al. 2011, p. 18). Based on a recommendation in the Service's 5-year review of the species' status (USFWS 2008a, p. 45), the Service reanalyzed the 27 recovery units identified in the draft bull trout recovery plan (USFWS 2002a, p. 48) by utilizing, in part, information from previous genetic studies and new information from additional analysis (Ardren et al. 2011, entire). In this examination, the Service applied relevant factors from the joint Service and National Marine Fisheries Service Distinct Population Segment (DPS) policy (USFWS 1996, entire) and subsequently identified six draft recovery units that contain assemblages of core areas that retain genetic and ecological integrity across the range of bull trout in the coterminous United States. These six draft recovery units were used to inform designation of critical habitat for bull trout by providing a context for deciding what habitats are essential for recovery (USFWS 2010, p. 63898). The six draft recovery units identified for bull trout in the coterminous United States include: Coastal, Klamath, Mid-Columbia, Columbia Headwaters, Saint Mary, and Upper Snake. These six draft recovery units were also identified in the Service's revised recovery plan (USFWS 2015, p. vii) and designated as final recovery units.

Population Dynamics

Although bull trout are widely distributed over a large geographic area, they exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, p. 4). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders et al. 1991, entire). Burkey (1989, entire) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth for local populations may be low and probability of extinction high (Burkey 1989, entire; Burkey 1995, entire).

Metapopulation concepts of conservation biology theory have been suggested relative to the distribution and characteristics of bull trout, although empirical evidence is relatively scant (Rieman and McIntyre 1993, p. 15; Dunham and Rieman 1999, entire; Rieman and Dunham 2000, entire). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994, pp. 189-190). For inland bull trout, metapopulation theory is likely most applicable at the watershed scale where habitat consists of discrete patches or collections of habitat capable of supporting local populations; local populations are for the most part independent and represent discrete reproductive units; and long-term, low-rate dispersal patterns among component populations influences the persistence of at least some of the local populations (Rieman and Dunham 2000, entire). Ideally, multiple local populations distributed throughout a watershed provide a mechanism for spreading risk because the simultaneous loss of all local populations is unlikely. However, habitat alteration, primarily through the construction of impoundments, dams, and water diversions has fragmented habitats, eliminated migratory corridors, and in many cases isolated bull trout in the headwaters of tributaries (Rieman and Clayton 1997, pp. 10-12; Dunham and Rieman 1999, p. 645; Spruell et al. 1999, pp. 118-120; Rieman and Dunham 2000, p. 55).

Human-induced factors as well as natural factors affecting bull trout distribution have likely limited the expression of the metapopulation concept for bull trout to patches of habitat within the overall distribution of the species (Dunham and Rieman 1999, entire). However, despite the theoretical fit, the relatively recent and brief time period during which bull trout investigations have taken place does not provide certainty as to whether a metapopulation dynamic is occurring (e.g., a balance between local extirpations and recolonizations) across the range of the bull trout or whether the persistence of bull trout in large or closely interconnected habitat patches (Dunham and Rieman 1999, entire) is simply reflective of a general deterministic trend towards extinction of the species where the larger or interconnected patches are relics of historically wider distribution (Rieman and Dunham 2000, pp. 56-57). Recent research (Whiteley et al. 2003, entire) does, however, provide genetic evidence for the presence of a metapopulation process for bull trout, at least in the Boise River Basin of Idaho.

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, p. 4). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing

substrate, and migratory corridors (Fraley and Shepard 1989, entire; Goetz 1989, pp. 23, 25; Hoelscher and Bjornn 1989, pp. 19, 25; Howell and Buchanan 1992, pp. 30, 32; Pratt 1992, entire; Rich 1996, p. 17; Rieman and McIntyre 1993, pp. 4-6; Rieman and McIntyre 1995, entire; Sedell and Everest 1991, entire; Watson and Hillman 1997, entire). Watson and Hillman (1997, pp. 247-250) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, pp. 4-6), bull trout should not be expected to simultaneously occupy all available habitats.

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993, p. 2). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, p. 2; Spruell et al. 1999, entire). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams, and spawning habitats are generally characterized by temperatures that drop below 9 °C in the fall (Fraley and Shepard 1989, p. 137; Pratt 1992, p. 5; Rieman and McIntyre 1993, p. 2).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992, pp 7-8; Rieman and McIntyre 1993, p. 7). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (Buchanan and Gregory 1997, p. 4; Goetz 1989, p. 22). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996, entire) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C, within a temperature gradient of 8 °C to 15 °C. In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003, p. 900) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C.

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997, p. 2; Fraley and Shepard 1989, pp. 133, 135; Rieman and McIntyre 1993, pp. 3-4; Rieman and McIntyre 1995, p. 287). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick 2002, pp. 6 and 13).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, p. 137; Goetz 1989, p. 19; Hoelscher and Bjornn 1989, p. 38; Pratt 1992, entire; Rich 1996, pp. 4-5; Sedell and Everest 1991, entire; Sexauer and James 1997, entire; Thomas 1992, pp. 4-6; Watson and Hillman 1997, p. 238). Maintaining bull trout habitat requires natural stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993, pp. 5-6). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, p. 364). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989, p. 141; Pratt 1992, p. 6; Pratt and Huston 1993, p. 70). Pratt (1992, p. 6) indicated that increases in fine sediment reduce egg survival and emergence.

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Fish growth depends on the quantity and quality of food that is eaten, and as fish grow their foraging strategy changes as their food changes, in quantity, size, or other characteristics (Quinn 2005, pp. 195-200). Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, p. 58; Donald and Alger 1993, pp. 242-243; Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout feed on various fish species (Donald and Alger 1993, pp. 241-243; Fraley and Shepard 1989, pp. 135, 138; Leathe and Graham 1982, pp. 13, 50-56). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001, p. 204). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz et al. 2004, p. 105; WDFW et al. 1997, p. 23).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997, p. 25). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005, pp. 1078-1079; Goetz et al. 2004, entire).

Status and Distribution

Distribution and Demography

The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978, pp. 165-166; Bond 1992, p. 2). To the west, the bull trout's range includes Puget Sound, various coastal rivers of British Columbia, Canada, and

southeast Alaska (Bond 1992, p. 2). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (Cavender 1978, pp. 165-166; Brewin et al. 1997, entire).

Each of the following recovery units (below) is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions. No new local populations have been identified and no local populations have been lost since listing.

Coastal Recovery Unit

The Coastal Recovery Unit is located within western Oregon and Washington. Major geographic regions include the Olympic Peninsula, Puget Sound, and Lower Columbia River basins. The Olympic Peninsula and Puget Sound geographic regions also include their associated marine waters (Puget Sound, Hood Canal, Strait of Juan de Fuca, and Pacific Coast), which are critical in supporting the anadromous[3] life history form, unique to the Coastal Recovery Unit. The Coastal Recovery Unit is also the only unit that overlaps with the distribution of Dolly Varden (*Salvelinus malma*) (Ardren *et al*. 2011), another native char species that looks very similar to the bull trout (Haas and McPhail 1991). The two species have likely had some level of historic introgression in this part of their range (Redenbach and Taylor 2002). The Lower Columbia River major geographic region includes the lower mainstem Columbia River, an important migratory waterway essential for providing habitat and population connectivity within this region. In the Coastal Recovery Unit, there are 21 existing bull trout core areas which have been designated, including the recently reintroduced Clackamas River population, and 4 core areas have been identified that could be re-established. Core areas within the recovery unit are distributed among these three major geographic regions (Puget Sound also includes one core area that is actually part of the lower Fraser River system in British Columbia, Canada) (USFWS 2015a, p. A-1).

The current demographic status of bull trout in the Coastal Recovery Unit is variable across the unit. Populations in the Puget Sound region generally tend to have better demographic status, followed by the Olympic Peninsula, and finally the Lower Columbia River region. However, population strongholds do exist across the three regions. The Lower Skagit River and Upper Skagit River core areas in the Puget Sound region likely contain two of the most abundant bull trout populations with some of the most intact habitat within this recovery unit. The Lower Deschutes River core area in the Lower Columbia River region also contains a very abundant bull trout population and has been used as a donor stock for re-establishing the Clackamas River population (USFWS 2015a, p. A-6).

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3 Anadromous: Life history pattern of spawning and rearing in fresh water and migrating to salt water areas to mature.

Puget Sound Region

In the Puget Sound region, bull trout populations are concentrated along the eastern side of Puget Sound with most core areas concentrated in central and northern Puget Sound.

Although the Chilliwack River core area is considered part of this region, it is technically connected to the Fraser River system and is transboundary with British Columbia making its distribution unique within the region. Most core areas support a mix of anadromous and fluvial life history forms, with at least two core areas containing a natural adfluvial life history (Chilliwack River core area [Chilliwack Lake] and Chester Morse Lake core area). Overall demographic status of core areas generally improves as you move from south Puget Sound to north Puget Sound. Although comprehensive trend data are lacking, the current condition of core areas within this region are likely stable overall, although some at depressed abundances. Two core areas (Puyallup River and Stillaguamish River) contain local populations at either very low abundances (Upper Puyallup and Mowich Rivers) or that have likely become locally extirpated (Upper Deer Creek, South Fork Canyon Creek, and Greenwater River). Connectivity among and within core areas of this region is generally intact. Most core areas in this region still have significant amounts of headwater habitat within protected and relatively pristine areas (e.g., North Cascades National Park, Mount Rainier National Park, Skagit Valley Provincial Park, Manning Provincial Park, and various wilderness or recreation areas) (USFWS 2015a, p. A-7).

Olympic Peninsula Region

In the Olympic Peninsula region, distribution of core areas is somewhat disjunct, with only one located on the west side of Hood Canal on the eastern side of the peninsula, two along the Strait of Juan de Fuca on the northern side of the peninsula, and three along the Pacific Coast on the western side of the peninsula. Most core areas support a mix of anadromous and fluvial life history forms, with at least one core area also supporting a natural adfluvial life history (Quinault River core area [Quinault Lake]). Demographic status of core areas is poorest in Hood Canal and Strait of Juan de Fuca, while core areas along the Pacific Coast of Washington likely have the best demographic status in this region. The connectivity between core areas in these disjunct regions is believed to be naturally low due to the geographic distance between them.

Internal connectivity is currently poor within the Skokomish River core area (Hood Canal) and is being restored in the Elwha River core area (Strait of Juan de Fuca). Most core areas in this region still have their headwater habitats within relatively protected areas (Olympic National Park and wilderness areas) (USFWS 2015a, p. A-7).

Lower Columbia River Region

In the Lower Columbia River region, the majority of core areas are distributed along the Cascade Crest on the Oregon side of the Columbia River. Only two of the seven core areas in this region are in Washington. Most core areas in the region historically supported a fluvial life history form, but many are now adfluvial due to reservoir

construction. However, there is at least one core area supporting a natural adfluvial life history (Odell Lake) and one supporting a natural, isolated, resident life history (Klickitat River [West Fork Klickitat]). Status is highly variable across this region, with one relative stronghold (Lower Deschutes core area) existing on the Oregon side of the Columbia River. The Lower Columbia River region also contains three watersheds (North Santiam River, Upper Deschutes River, and White Salmon River) that could potentially become re-established core areas within the Coastal Recovery Unit. Although the South Santiam River has been identified as a historic core area, there remains uncertainty as to whether or not historical observations of bull trout represented a self-sustaining population. Current habitat conditions in the South Santiam River are thought to be unable to support bull trout spawning and rearing. Adult abundances within the majority of core areas in this region are relatively low, generally 300 or fewer individuals.

Most core populations in this region are not only isolated from one another due to dams or natural barriers, but they are internally fragmented as a result of manmade barriers. Local populations are often disconnected from one another or from potential foraging habitat. In the Coastal Recovery Unit, adult abundance may be lowest in the Hood River and Odell Lake core areas, which each contain fewer than 100 adults. Bull trout were reintroduced in the Middle Fork Willamette River in 1990 above Hills Creek Reservoir. Successful reproduction was first documented in 2006, and has occurred each year since (USFWS 2015a, p. A-8). Natural reproducing populations of bull trout are present in the McKenzie River basin (USFWS 2008d, pp. 65-67). Bull trout were more recently reintroduced into the Clackamas River basin in the summer of 2011 after an extensive feasibility analysis (Shively et al. 2007, Hudson et al. 2015). Bull trout from the Lower Deschutes core area are being utilized for this reintroduction effort (USFWS 2015a, p. A-8).

Klamath Recovery Unit

Bull trout in the Klamath Recovery Unit have been isolated from other bull trout populations for the past 10,000 years and are recognized as evolutionarily and genetically distinct (Minckley et al. 1986; Leary et al. 1993; Whitesel et al. 2004; USFWS 2008a; Ardren et al. 2011). As such, there is no opportunity for bull trout in another recovery unit to naturally re- colonize the Klamath Recovery Unit if it were to become extirpated. The Klamath Recovery Unit lies at the southern edge of the species range and occurs in an arid portion of the range of bull trout.

Bull trout were once widespread within the Klamath River basin (Gilbert 1897; Dambacher et al. 1992; Ziller 1992; USFWS 2002b), but habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, and past fisheries management practices have greatly reduced their distribution. Bull trout abundance also has been severely reduced, and the remaining populations are highly fragmented and vulnerable to natural or manmade factors that place them at a high risk of extirpation (USFWS 2002b). The presence of nonnative brook trout (*Salvelinus fontinalis*), which compete and hybridize with bull trout, is a particular threat to bull trout persistence throughout the Klamath Recovery Unit (USFWS 2015b, pp. B-3-4).

Upper Klamath Lake Core Area

The Upper Klamath Lake core area comprises two bull trout local populations (Sun Creek and Threemile Creek). These local populations likely face an increased risk of extirpation because they are isolated and not interconnected with each other. Extirpation of other local populations in the Upper Klamath Lake core area has occurred in recent times (1970s). Populations in this core area are genetically distinct from those in the other two core areas in the Klamath Recovery Unit (USFWS 2008b), and in comparison, genetic variation within this core area is lowest. The two local populations have been isolated by habitat fragmentation and have experienced population bottlenecks. As such, currently unoccupied habitat is needed to restore connectivity between the two local populations and to establish additional populations. This unoccupied habitat includes canals, which now provide the only means of connectivity as migratory corridors. Providing full volitional connectivity for bull trout, however, also introduces the risk of invasion by brook trout, which are abundant in this core area.

Bull trout in the Upper Klamath Lake core area formerly occupied Annie Creek, Sevenmile Creek, Cherry Creek, and Fort Creek, but are now extirpated from these locations. The last remaining local populations, Sun Creek and Threemile Creek, have received focused attention. Brook trout have been removed from bull trout occupied reaches, and these reaches have been intentionally isolated to prevent brook trout reinvasion. As such, over the past few generations these populations have become stable and have increased in distribution and abundance. In 1996, the Threemile Creek population had approximately 50 fish that occupied a 1.4-km (0.9-mile) reach (USFWS 2002b). In 2012, a mark-resight population estimate was completed in Threemile Creek, which indicated an abundance of 577 (95 percent confidence interval = 475 to 679) age-1+ fish (ODFW 2012). In addition, the length of the distribution of bull trout in Threemile Creek had increased to 2.7 km (1.7 miles) by 2012 (USFWS unpublished data). Between 1989 and 2010, bull trout abundance in Sun Creek increased approximately tenfold (from approximately 133 to 1,606 age-1+ fish) and distribution increased from approximately 1.9 km (1.2 miles) to 11.2 km (7.0 miles) (Buktenica et al. 2013) (USFWS 2015b, p. B-5).

Sycan River Core Area

The Sycan River core area is comprised of one local population, Long Creek. Long Creek likely faces greater risk of extirpation because it is the only remaining local population due to extirpation of all other historic local populations. Bull trout previously occupied Calahan Creek, Coyote Creek, and the Sycan River, but are now extirpated from these locations (Light et al. 1996). This core area's local population is genetically distinct from those in the other two core areas (USFWS 2008b). This core area also is essential for recovery because bull trout in this core area exhibit both resident[4] and fluvial life histories, which are important for representing diverse life history expression in the

4 Resident: Life history pattern of residing in tributary streams for the fish's entire life without migrating.

Klamath Recovery Unit. Migratory bull trout are able to grow larger than their resident counterparts, resulting in greater fecundity and higher reproductive potential (Rieman and McIntyre 1993). Migratory life history forms also have been shown to be important for population persistence and resilience (Dunham et al. 2008).

The last remaining population (Long Creek) has received focused attention in an effort to ensure it is not also extirpated. In 2006, two weirs were removed from Long Creek, which increased the amount of occupied foraging, migratory, and overwintering (FMO) habitat by 3.2 km (2.0 miles). Bull trout currently occupy approximately 3.5 km (2.2 miles) of spawning/rearing habitat, including a portion of an unnamed tributary to upper Long Creek, and seasonally use 25.9 km (16.1 miles) of FMO habitat. Brook trout also inhabit Long Creek and have been the focus of periodic removal efforts. No recent statistically rigorous population estimate has been completed for Long Creek; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 842 individuals (USFWS 2002b). Currently unoccupied habitat is needed to establish additional local populations, although brook trout are widespread in this core area and their management will need to be considered in future recovery efforts. In 2014, the Klamath Falls Fish and Wildlife Office of the Service established an agreement with the U.S. Geological Survey to undertake a structured decision making process to assist with recovery planning of bull trout populations in the Sycan River core area (USFWS 2015b, p. B-6).

Upper Sprague River Core Area

The Upper Sprague River core area comprises five bull trout local populations, placing the core area at an intermediate risk of extinction. The five local populations include Boulder Creek, Dixon Creek, Deming Creek, Leonard Creek, and Brownsworth Creek. These local populations may face a higher risk of extirpation because not all are interconnected. Bull trout local populations in this core area are genetically distinct from those in the other two Klamath Recovery Unit core areas (USFWS 2008b). Migratory bull trout have occasionally been observed in the North Fork Sprague River (USFWS 2002b). Therefore, this core area also is essential for recovery in that bull trout here exhibit a resident life history and likely a fluvial life history, which are important for conserving diverse life history expression in the Klamath Recovery Unit as discussed above for the Sycan River core area.

The Upper Sprague River core area population of bull trout has experienced a decline from historic levels, although less is known about historic occupancy in this core area. Bull trout are reported to have historically occupied the South Fork Sprague River, but are now extirpated from this location (Buchanan et al. 1997). The remaining five populations have received focused attention. Although brown trout (*Salmo trutta*) co-occur with bull trout and exist in adjacent habitats, brook trout do not overlap with existing bull trout populations. Efforts have been made to increase connectivity of existing bull trout populations by replacing culverts that create barriers. Thus, over the past few generations, these populations have likely been stable and increased in distribution. Population abundance has been estimated recently for Boulder Creek (372 + 62 percent; Hartill and Jacobs 2007), Dixon Creek (20 + 60 percent; Hartill and Jacobs

2007), Deming Creek (1,316 + 342; Moore 2006), and Leonard Creek (363 + 37 percent; Hartill and Jacobs 2007). No statistically rigorous population estimate has been completed for the Brownsworth Creek local population; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 964 individuals (USFWS 2002b). Additional local populations need to be established in currently unoccupied habitat within the Upper Sprague River core area, although brook trout are widespread in this core area and will need to be considered in future recovery efforts (USFWS 2015b, p. B-7).

Mid-Columbia Recovery Unit

The Mid-Columbia Recovery Unit (RU) comprises 24 bull trout core areas, as well as 2 historically occupied core areas and 1 research needs area. The Mid-Columbia RU is recognized as an area where bull trout have co-evolved with salmon, steelhead, lamprey, and other fish populations. Reduced fish numbers due to historic overfishing and land management changes have caused changes in nutrient abundance for resident migratory fish like the bull trout. The recovery unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. Major drainages include the Methow River, Wenatchee River, Yakima River, John Day River, Umatilla River, Walla Walla River, Grande Ronde River, Imnaha River, Clearwater River, and smaller drainages along the Snake River and Columbia River (USFWS 2015c, p. C-1).

The Mid-Columbia RU can be divided into four geographic regions the Lower Mid-Columbia, which includes all core areas that flow into the Columbia River below its confluence with the 1) Snake River; 2) the Upper Mid-Columbia, which includes all core areas that flow into the Columbia River above its confluence with the Snake River; 3) the Lower Snake, which includes all core areas that flow into the Snake River between its confluence with the Columbia River and Hells Canyon Dam; and 4) the Mid-Snake, which includes all core areas in the Mid-Columbia RU that flow into the Snake River above Hells Canyon Dam. These geographic regions are composed of neighboring core areas that share similar bull trout genetic, geographic (hydrographic), and/or habitat characteristics. Conserving bull trout in geographic regions allows for the maintenance of broad representation of genetic diversity, provides neighboring core areas with potential source populations in the event of local extirpations, and provides a broad array of options among neighboring core areas to contribute recovery under uncertain environmental change USFWS 2015c, pp. C-1-2).

The current demographic status of bull trout in the Mid-Columbia Recovery Unit is highly variable at both the RU and geographic region scale. Some core areas, such as the Umatilla, Asotin, and Powder Rivers, contain populations so depressed they are likely suffering from the deleterious effects of small population size. Conversely, strongholds do exist within the recovery unit, predominantly in the Lower Snake geographic area. Populations in the Imnaha, Little Minam, Clearwater, and Wenaha Rivers are likely some of the most abundant. These populations are all completely or partially within the bounds of protected wilderness areas and have some of the most intact habitat in the recovery unit. Status in some core areas is relatively unknown, but all indications in these core areas suggest population trends are declining, particularly in the core areas of the John Day Basin (USFWS 2015c, p. C-5).

Lower Mid-Columbia Region

In the Lower Mid-Columbia Region, core areas are distributed along the western portion of the Blue Mountains in Oregon and Washington. Only one of the six core areas is located completely in Washington. Demographic status is highly variable throughout the region. Status is the poorest in the Umatilla and Middle Fork John Day Core Areas. However, the Walla Walla River core area contains nearly pristine habitats in the headwater spawning areas and supports the most abundant populations in the region. Most core areas support both a resident and fluvial life history; however, recent evidence suggests a significant decline in the resident and fluvial life history in the Umatilla River and John Day core areas respectively. Connectivity between the core areas of the Lower Mid-Columbia Region is unlikely given conditions in the connecting FMO habitats. Connection between the Umatilla, Walla Walla and Touchet core areas is uncommon but has been documented, and connectivity is possible between core areas in the John Day Basin. Connectivity between the John Day core areas and Umatilla/Walla Walla/Touchet core areas is unlikely (USFWS 2015c, pp. C-5-6).

Upper Mid-Columbia Region

In the Upper Mid-Columbia Region, core areas are distributed along the eastern side of the Cascade Mountains in Central Washington. This area contains four core areas (Yakima, Wenatchee, Entiat, and Methow), the Lake Chelan historic core area, and the Chelan River, Okanogan River, and Columbia River FMO areas. The core area populations are generally considered migratory, though they currently express both migratory (fluvial and adfluvial) and resident forms. Residents are located both above and below natural barriers (*i.e.*, Early Winters Creek above a natural falls; and Ahtanum in the Yakima likely due to long lack of connectivity from irrigation withdrawal). In terms of uniqueness and connectivity, the genetics baseline, radio-telemetry, and PIT tag studies identified unique local populations in all core areas. Movement patterns within the core areas; between the lower river, lakes, and other core areas; and between the Chelan, Okanogan, and Columbia River FMO occurs regularly for some of the Wenatchee, Entiat, and Methow core area populations. This type of connectivity has been displayed by one or more fish, typically in non-spawning movements within FMO. More recently, connectivity has been observed between the Entiat and Yakima core areas by a juvenile bull trout tagged in the Entiat moving in to the Yakima at Prosser Dam and returning at an adult size back to the Entiat. Genetics baselines identify unique populations in all four core areas (USFWS 2015c, p. C-6).

The demographic status is variable in the Upper-Mid Columbia region and ranges from good to very poor. The Service's 2008 5-year Review and Conservation Status Assessment described the Methow and Yakima Rivers at risk, with a rapidly declining trend. The Entiat River was listed at risk with a stable trend, and the Wenatchee River as having a potential risk, and with a stable trend. Currently, the Entiat River is considered to be declining rapidly due to much reduced redd counts. The Wenatchee River is able to exhibit all freshwater life histories with connectivity to Lake Wenatchee, the Wenatchee River and all its local populations, and to the Columbia River and/or other core areas in the region. In the Yakima core area some populations exhibit life history forms different

from what they were historically. Migration between local populations and to and from spawning habitat is generally prevented or impeded by headwater storage dams on irrigation reservoirs, connectivity between tributaries and reservoirs, and within lower portions of spawning and rearing habitat and the mainstem Yakima River due to changed flow patterns, low instream flows, high water temperatures, and other habitat impediments. Currently, the connectivity in the Yakima Core area is truncated to the degree that not all populations are able to contribute gene flow to a functional metapopulation (USFWS 2015c, pp. C-6-7)

Lower Snake Region

Demographic status is variable within the Lower Snake Region. Although trend data are lacking, several core areas in the Grande Ronde Basin and the Imnaha core area are thought to be stable. The upper Grande Ronde Core Area is the exception where population abundance is considered depressed. Wenaha, Little Minam, and Imnaha Rivers are strongholds (as mentioned above), as are most core areas in the Clearwater River basin. Most core areas contain populations that express both a resident and fluvial life history strategy. There is potential that some bull trout in the upper Wallowa River are adfluvial. There is potential for connectivity between core areas in the Grande Ronde basin, however conditions in FMO are limiting (USFWS 2015c, p. C-7).

Middle Snake Region

In the Middle Snake Region, core areas are distributed along both sides of the Snake River above Hells Canyon Dam. The Powder River and Pine Creek basins are in Oregon and Indian Creek and Wildhorse Creek are on the Idaho side of the Snake River. Demographic status of the core areas is poorest in the Powder River Core Area where populations are highly fragmented and severely depressed. The East Pine Creek population in the Pine-Indian-Wildhorse Creeks core area is likely the most abundant within the region. Populations in both core areas primarily express a resident life history strategy; however, some evidence suggests a migratory life history still exists in the Pine-Indian-Wildhorse Creeks core area. Connectivity is severely impaired in the Middle Snake Region. Dams, diversions and temperature barriers prevent movement among populations and between core areas. Brownlee Dam isolates bull trout in Wildhorse Creek from other populations (USFWS 2015c, p. C-7).

Columbia Headwaters Recovery Unit

The Columbia Headwaters Recovery Unit (CHRU) includes western Montana, northern Idaho, and the northeastern corner of Washington. Major drainages include the Clark Fork River basin and its Flathead River contribution, the Kootenai River basin, and the Coeur d'Alene Lake basin. In this implementation plan for the CHRU we have slightly reorganized the structure from the 2002 Draft Recovery Plan, based on latest available science and fish passage improvements that have rejoined previously fragmented habitats. We now identify 35 bull trout core areas (compared to 47 in 2002) for this recovery unit. Fifteen of the 35 are referred to as "complex" core areas as they represent large interconnected habitats, each containing multiple spawning

streams considered to host separate and largely genetically identifiable local populations. The 15 complex core areas contain the majority of individual bull trout and the bulk of the designated critical habitat (USFWS 2010).

However, somewhat unique to this recovery unit is the additional presence of 20 smaller core areas, each represented by a single local population. These “simple” core areas are found in remote glaciated headwater basins, often in Glacier National Park or federally-designated wilderness areas, but occasionally also in headwater valley bottoms. Many simple core areas are upstream of waterfalls or other natural barriers to fish migration. In these simple core areas bull trout have apparently persisted for thousands of years despite small populations and isolated existence. As such, simple core areas meet the criteria for core area designation and continue to be valued for their uniqueness, despite limitations of size and scope. Collectively, the 20 simple core areas contain less than 3 percent of the total bull trout core area habitat in the CHRU, but represent significant genetic and life history diversity (Meeuwig et al. 2010). Throughout this recovery unit implementation plan, we often separate our analyses to distinguish between complex and simple core areas, both in respect to threats as well as recovery actions (USFWS 2015d, pp. D-1-2).

In order to effectively manage the recovery unit implementation plan (RUIP) structure in this large and diverse landscape, the core areas have been separated into the following five natural geographic assemblages.

> <u>*Upper Clark Fork Geographic Region*</u>
>
> Starting at the Clark Fork River headwaters, the *Upper Clark Fork Geographic Region* comprises seven complex core areas, each of which occupies one or more major watersheds contributing to the Clark Fork basin (*i.e.*, Upper Clark Fork River, Rock Creek, Blackfoot River, Clearwater River and Lakes, Bitterroot River, West Fork Bitterroot River, and Middle Clark Fork River core areas) (USFWS 2015d, p. D-2).
>
> <u>*Lower Clark Fork Geographic Region*</u>
>
> The seven headwater core areas flow into the *Lower Clark Fork Geographic Region*, which comprises two complex core areas, Lake Pend Oreille and Priest Lake. Because of the systematic and jurisdictional complexity (three States and a Tribal entity) and the current degree of migratory fragmentation caused by five mainstem dams, the threats and recovery actions in the Lake Pend Oreille (LPO) core area are very complex and are described in three parts. LPO-A is upstream of Cabinet Gorge Dam, almost entirely in Montana, and includes the mainstem Clark Fork River upstream to the confluence of the Flathead River as well as the portions of the lower Flathead River (*e.g.*, Jocko River) on the Flathead Indian Reservation. LPO-B is the Pend Oreille lake basin proper and its tributaries, extending between Albeni Falls Dam downstream from the outlet of Lake Pend Oreille and Cabinet Gorge Dam just upstream of the lake; almost entirely in Idaho. LPO-C is the lower basin (*i.e.*, lower Pend Oreille River), downstream of Albeni Falls Dam to Boundary Dam (1 mile upstream from the Canadian border) and bisected by Box Canyon Dam; including portions of Idaho, eastern Washington, and the Kalispel Reservation (USFWS 2015d, p. D-2).

Historically, and for current purposes of bull trout recovery, migratory connectivity among these separate fragments into a single entity remains a primary objective.

<u>*Flathead Geographic Region*</u>

The *Flathead Geographic Region* includes a major portion of northwestern Montana upstream of Kerr Dam on the outlet of Flathead Lake. The complex core area of Flathead Lake is the hub of this area, but other complex core areas isolated by dams are Hungry Horse Reservoir (formerly South Fork Flathead River) and Swan Lake. Within the glaciated basins of the Flathead River headwaters are 19 simple core areas, many of which lie in Glacier National Park or the Bob Marshall and Great Bear Wilderness areas and some of which are isolated by natural barriers or other features (USFWS 2015d, p. D-2).

<u>*Kootenai Geographic Region*</u>

To the northwest of the Flathead, in an entirely separate watershed, lies the *Kootenai Geographic Region*. The Kootenai is a uniquely patterned river system that originates in southeastern British Columbia, Canada. It dips, in a horseshoe configuration, into northwest Montana and north Idaho before turning north again to re-enter British Columbia and eventually join the Columbia River headwaters in British Columbia. The *Kootenai Geographic Region* contains two complex core areas (Lake Koocanusa and the Kootenai River) bisected since the 1970's by Libby Dam, and also a single naturally isolated simple core area (Bull Lake). Bull trout in both of the complex core areas retain strong migratory connections to populations in British Columbia (USFWS 2015d, p. D-3).

<u>*Coeur d'Alene Geographic Region*</u>

Finally, the *Coeur d'Alene Geographic Region* consists of a single, large complex core area centered on Coeur d'Alene Lake. It is grouped into the CHRU for purposes of physical and ecological similarity (adfluvial bull trout life history and nonanadromous linkage) rather than due to watershed connectivity with the rest of the CHRU, as it flows into the mid-Columbia River far downstream of the Clark Fork and Kootenai systems (USFWS 2015d, p. D-3).

Upper Snake Recovery Unit

The Upper Snake Recovery Unit includes portions of central Idaho, northern Nevada, and eastern Oregon. Major drainages include the Salmon River, Malheur River, Jarbidge River, Little Lost River, Boise River, Payette River, and the Weiser River. The Upper Snake Recovery Unit contains 22 bull trout core areas within 7 geographic regions or major watersheds: Salmon River (10 core areas, 123 local populations), Boise River (2 core areas, 29 local populations), Payette River (5 core areas, 25 local populations), Little Lost River (1 core area, 10 local populations), Malheur River (2 core areas, 8 local populations), Jarbidge River (1 core area, 6 local populations), and Weiser River (1 core area, 5 local populations). The Upper Snake Recovery Unit includes a total of 206 local populations, with almost 60 percent being present in the Salmon River watershed (USFWS 2015e, p. E-1).

Three major bull trout life history expressions are present in the Upper Snake Recovery Unit, adfluvial[5], fluvial[6], and resident populations. Large areas of intact habitat exist primarily in the Salmon drainage, as this is the only drainage in the Upper Snake Recovery Unit that still flows directly into the Snake River; most other drainages no longer have direct connectivity due to irrigation uses or instream barriers. Bull trout in the Salmon basin share a genetic past with bull trout elsewhere in the Upper Snake Recovery Unit. Historically, the Upper Snake Recovery Unit is believed to have largely supported the fluvial life history form; however, many core areas are now isolated or have become fragmented watersheds, resulting in replacement of the fluvial life history with resident or adfluvial forms. The Weiser River, Squaw Creek, Pahsimeroi River, and North Fork Payette River core areas contain only resident populations of bull trout (USFWS 2015e, pp. E-1-2).

Salmon River

The Salmon River basin represents one of the few basins that are still free-flowing down to the Snake River. The core areas in the Salmon River basin do not have any major dams and a large extent (approximately 89 percent) is federally managed, with large portions of the Middle Fork Salmon River and Middle Fork Salmon River - Chamberlain core areas occurring within the Frank Church River of No Return Wilderness. Most core areas in the Salmon River basin contain large populations with many occupied stream segments. The Salmon River basin contains 10 of the 22 core areas in the Upper Snake Recovery Unit and contains the majority of the occupied habitat. Over 70 percent of occupied habitat in the Upper Snake Recovery Unit occurs in the Salmon River basin as well as 123 of the 206 local populations. Connectivity between core areas in the Salmon River basin is intact; therefore it is possible for fish in the mainstem Salmon to migrate to almost any Salmon River core area or even the Snake River.

Connectivity within Salmon River basin core areas is mostly intact except for the Pahsimeroi River and portions of the Lemhi River. The Upper Salmon River, Lake Creek, and Opal Lake core areas contain adfluvial populations of bull trout, while most of the remaining core areas contain fluvial populations; only the Pahsimeroi contains strictly resident populations. Most core areas appear to have increasing or stable trends but trends are not known in the Pahsimeroi, Lake Creek, or Opal Lake core areas. The Idaho Department of Fish and Game reported trend data from 7 of the 10 core areas. This trend data indicated that populations were stable or increasing in the Upper Salmon River, Lemhi River, Middle Salmon River-Chamberlain, Little Lost River, and the South Fork Salmon River (IDFG 2005, 2008). Trends were stable or decreasing in the Little-Lower Salmon River, Middle Fork Salmon River, and the Middle Salmon River-Panther (IDFG 2005, 2008).

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5 Adfluvial: Life history pattern of spawning and rearing in tributary streams and migrating to lakes or reservoirs to mature.

6 Fluvial: Life history pattern of spawning and rearing in tributary streams and migrating to larger rivers to mature.

Boise River

In the Boise River basin, two large dams are impassable barriers to upstream fish movement: Anderson Ranch Dam on the South Fork Boise River, and Arrowrock Dam on the mainstem Boise River. Fish in Anderson Ranch Reservoir have access to the South Fork Boise River upstream of the dam. Fish in Arrowrock Reservoir have access to the North Fork Boise River, Middle Fork Boise River, and lower South Fork Boise River. The Boise River basin contains 2 of the 22 core areas in the Upper Snake Recovery Unit. The core areas in the Boise River basin account for roughly 12 percent of occupied habitat in the Upper Snake Recovery Unit and contain 29 of the 206 local populations. Approximately 90 percent of both Arrowrock and Anderson Ranch core areas are federally owned; most lands are managed by the U.S. Forest Service, with some portions occurring in designated wilderness areas. Both the Arrowrock core area and the Anderson Ranch core area are isolated from other core areas. Both core areas contain fluvial bull trout that exhibit adfluvial characteristics and numerous resident populations. The Idaho Department of Fish and Game in 2014 determined that the Anderson Ranch core area had an increasing trend while trends in the Arrowrock core area is unknown (USFWS 2015e).

Payette River

The Payette River basin contains three major dams that are impassable barriers to fish: Deadwood Dam on the Deadwood River, Cascade Dam on the North Fork Payette River, and Black Canyon Reservoir on the Payette River. Only the Upper South Fork Payette River and the Middle Fork Payette River still have connectivity, the remaining core areas are isolated from each other due to dams. Both fluvial and adfluvial life history expression are still present in the Payette River basin but only resident populations are present in the Squaw Creek and North Fork Payette River core areas. The Payette River basin contains 5 of the 22 core areas and 25 of the 206 local populations in the recovery unit. Less than 9 percent of occupied habitat in the recovery unit is in this basin. Approximately 60 percent of the lands in the core areas are federally owned and the majority is managed by the U.S. Forest Service. Trend data are lacking and the current condition of the various core areas is unknown, but there is concern due to the current isolation of three (North Fork Payette River, Squaw Creek, Deadwood River) of the five core areas; the presence of only resident local populations in two (North Fork Payette River, Squaw Creek) of the five core areas; and the relatively low numbers present in the North Fork core area (USFWS 2015e, p. E-8).

Jarbidge River

The Jarbidge River core area contains two major fish barriers along the Bruneau River: the Buckaroo diversion and C. J. Strike Reservoir. Bull trout are not known to migrate down to the Snake River. There is one core area in the basin, with populations in the Jarbidge River; this watershed does not contain any barriers. Approximately 89 percent of the Jarbidge core area is federally owned. Most lands are managed by either the Forest Service or Bureau of Land Management. A large portion of the core area is within the Bruneau-Jarbidge Wilderness area. A tracking study has documented bull trout

population connectivity among many of the local populations, in particular between West Fork Jarbidge River and Pine Creek. Movement between the East and West Fork Jarbidge River has also been documented; therefore both resident and fluvial populations are present. The core area contains six local populations and 3 percent of the occupied habitat in the recovery unit. Trend data are lacking within this core area (USFWS 2015e, p. E-9).

Little Lost River

The Little Lost River basin is unique in that the watershed is within a naturally occurring hydrologic sink and has no connectivity with other drainages. A small fluvial population of bull trout may still exist, but it appears that most populations are predominantly resident populations. There is one core area in the Little Lost basin, and approximately 89 percent of it is federally owned by either the U.S. Forest Service or Bureau of Land Management. The core area contains 10 local populations and less than 3 percent of the occupied habitat in the recovery unit. The current trend condition of this core area is likely stable, with most bull trout residing in Upper Sawmill Canyon (IDFG 2014).

Malheur River

The Malheur River basin contains major dams that are impassable to fish. The largest are Warm Springs Dam, impounding Warm Springs Reservoir on the mainstem Malheur River, and Agency Valley Dam, impounding Beulah Reservoir on the North Fork Malheur River. The dams result in two core areas that are isolated from each other and from other core areas. Local populations in the two core areas are limited to habitat in the upper watersheds. The Malheur River basin contains 2 of the 22 core areas and 8 of the 206 local populations in the recovery unit. Fluvial and resident populations are present in both core areas while adfluvial populations are present in the North Fork Malheur River. This basin contains less than 3 percent of the occupied habitat in the recovery unit, and approximately 60 percent of lands in the two core areas are federally owned. Trend data indicates that populations are declining in both core areas (USFWS 2015e, p. E-9).

Weiser River

The Weiser River basin contains local populations that are limited to habitat in the upper watersheds. The Weiser River basin contains only a single core area that consists of 5 of the 206 local populations in the recovery unit. Local populations occur in only three stream complexes in the upper watershed: 1) Upper Hornet Creek, 2) East Fork Weiser River, and 3) Upper Little Weiser River. These local populations include only resident life histories. This basin contains less than 2 percent of the occupied habitat in the recovery unit, and approximately 44 percent of lands are federally owned. Trend data from the Idaho Department of Fish and Game indicate that the populations in the Weiser core area are increasing (IDFG 2014) but it is considered vulnerable because local populations are isolated and likely do not express migratory life histories (USFWS 2015e, p.E-10).

St. Mary Recovery Unit

The Saint Mary Recovery Unit is located in northwest Montana east of the Continental Divide and includes the U.S. portions of the Saint Mary River basin, from its headwaters to the international boundary with Canada at the 49th parallel. The watershed and the bull trout population are linked to downstream aquatic resources in southern Alberta, Canada; the U.S. portion includes headwater spawning and rearing (SR) habitat in the tributaries and a portion of the FMO habitat in the mainstem of the Saint Mary River and Saint Mary lakes (Mogen and Kaeding 2001).

The Saint Mary Recovery Unit comprises four core areas; only one (Saint Mary River) is a complex core area with five described local bull trout populations (Divide, Boulder, Kennedy, Otatso, and Lee Creeks). Roughly half of the linear extent of available FMO habitat in the mainstem Saint Mary system (between Saint Mary Falls at the upstream end and the downstream Canadian border) is comprised of Saint Mary and Lower Saint Mary Lakes, with the remainder in the Saint Mary River. The other three core areas (Slide Lakes, Cracker Lake, and Red Eagle Lake) are simple core areas. Slide Lakes and Cracker Lake occur upstream of seasonal or permanent barriers and are comprised of genetically isolated single local bull trout populations, wholly within Glacier National Park, Montana. In the case of Red Eagle Lake, physical isolation does not occur, but consistent with other lakes in the adjacent Columbia Headwaters Recovery Unit, there is likely some degree of spatial separation from downstream Saint Mary Lake. As noted, the extent of isolation has been identified as a research need (USFWS 2015f, p. F-1).

Bull trout in the Saint Mary River complex core area are documented to exhibit primarily the migratory fluvial life history form (Mogen and Kaeding 2005a, 2005b), but there is doubtless some occupancy (though less well documented) of Saint Mary Lakes, suggesting a partly adfluvial adaptation. Since lake trout and northern pike are both native to the Saint Mary River system (headwaters of the South Saskatchewan River drainage draining to Hudson Bay), the conventional wisdom is that these large piscivores historically outcompeted bull trout in the lacustrine environment (Donald and Alger 1993, Martinez et al. 2009), resulting in a primarily fluvial niche and existence for bull trout in this system. This is an untested hypothesis and additional research into this aspect is needed (USFWS 2015f, p. F-3).

Bull trout populations in the simple core areas of the three headwater lake systems (Slide, Cracker, and Red Eagle Lakes) are, by definition, adfluvial; there are also resident life history components in portions of the Saint Mary River system such as Lower Otatso Creek (Mogen and Kaeding 2005a), further exemplifying the overall life history diversity typical of bull trout. Mogen and Kaeding (2001) reported that bull trout continue to inhabit nearly all suitable habitats accessible to them in the Saint Mary River basin in the United States. The possible exception is portions of Divide Creek, which appears to be intermittently occupied despite a lack of permanent migratory barriers, possibly due to low population size and erratic year class production (USFWS 2015f, p. F-3).

It should be noted that bull trout are found in minor portions of two additional U.S. watersheds (Belly and Waterton rivers) that were once included in the original draft recovery plan (USFWS 2002) but are no longer considered core areas in the final recovery plan (USFWS 2015) and are not addressed in that document. In Alberta, Canada, the Saint Mary River bull trout population

is considered at "high risk," while the Belly River is rated as "at risk" (ACA 2009). In the Belly River drainage, which enters the South Saskatchewan system downstream of the Saint Mary River in Alberta, some bull trout spawning is known to occur on either side of the international boundary. These waters are in the drainage immediately west of the Saint Mary River headwaters. However, the U.S. range of this population constitutes only a minor headwater migratory SR segment of an otherwise wholly Canadian population, extending less than 1 mile (0.6 km) into backcountry waters of Glacier National Park. The Belly River population is otherwise totally dependent on management within Canadian jurisdiction, with no natural migratory connection to the Saint Mary (USFWS 2015f, p. F-3).

Current status of bull trout in the Saint Mary River core area (U.S.) is considered strong (Mogen 2013). Migratory bull trout redd counts are conducted annually in the two major SR streams, Boulder and Kennedy creeks. Boulder Creek redd counts have ranged from 33 to 66 in the past decade, with the last 4 counts all 53 or higher. Kennedy Creek redd counts are less robust, ranging from 5 to 25 over the last decade, with a 2014 count of 20 (USFWS 2015f, p. F-3).

Generally, the demographic status of the Saint Mary River core area is believed to be good, with the exception of the Divide Creek local population. In this local population, there is evidence that a combination of ongoing habitat manipulation (Smillie and Ellerbroek 1991,F-5 NPS 1992) resulting in occasional historical passage issues, combined with low and erratic recruitment (DeHaan et al. 2011) has caused concern for the continuing existence of the local population.

While less is known about the demographic status of the three simple cores where redd counts are not conducted, all three appear to be self-sustaining and fluctuating within known historical population demographic bounds. Of the three simple core areas, demographic status in Slide Lakes and Cracker Lake appear to be functioning appropriately, but the demographic status in Red Eagle Lake is less well documented and believed to be less robust (USFWS 2015f, p. F-3).

Reasons for Listing

Bull trout distribution, abundance, and habitat quality have declined rangewide (Bond 1992, pp. 2-3; Schill 1992, p. 42; Thomas 1992, entire; Ziller 1992, entire; Rieman and McIntyre 1993, p. 1; Newton and Pribyl 1994, pp. 4-5; McPhail and Baxter 1996, p. 1). Several local extirpations have been documented, beginning in the 1950s (Rode 1990, pp. 26-32; Ratliff and Howell 1992, entire; Donald and Alger 1993, entire; Goetz 1994, p. 1; Newton and Pribyl 1994, pp. 8-9; Light et al. 1996, pp. 6-7; Buchanan et al. 1997, p. 15; WDFW 1998, pp. 2-3). Bull trout were extirpated from the southernmost portion of their historic range, the McCloud River in California, around 1975 (Rode 1990, p. 32). Bull trout have been functionally extirpated (i.e., few individuals may occur there but do not constitute a viable population) in the Coeur d'Alene River basin in Idaho and in the Lake Chelan and Okanogan River basins in Washington (USFWS 1998, pp. 31651-31652).

These declines result from the combined effects of habitat degradation and fragmentation, the blockage of migratory corridors; poor water quality, angler harvest and poaching, entrainment (process by which aquatic organisms are pulled through a diversion or other device) into diversion channels and dams, and introduced nonnative species. Specific land and water management activities that depress bull trout populations and degrade habitat include the effects

of dams and other diversion structures, forest management practices, livestock grazing, agriculture, agricultural diversions, road construction and maintenance, mining, and urban and rural development (Beschta et al. 1987, entire; Chamberlain et al. 1991, entire; Furniss et al. 1991, entire; Meehan 1991, entire; Nehlsen et al. 1991, entire; Sedell and Everest 1991, entire; Craig and Wissmar 1993pp, 18-19; Henjum et al. 1994, pp. 5-6; McIntosh et al. 1994, entire; Wissmar et al. 1994, entire; MBTSG 1995a, p. 1; MBTSG 1995b. pp. i-ii; MBTSG 1995c, pp. i-ii; MBTSG 1995d, p. 22; MBTSG 1995e, p. i; MBTSG 1996a, p. i-ii; MBTSG 1996b, p. i; MBTSG 1996c, p. i; MBTSG 1996d, p. i; MBTSG 1996e, p. i; MBTSG 1996f, p. 11; Light et al. 1996, pp. 6-7; USDA and USDI 1995, p. 2).

Emerging Threats

Climate Change

Climate change was not addressed as a known threat when bull trout was listed. The 2015 bull trout recovery plan and RUIPs summarize the threat of climate change and acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time due to anthropogenic climate change effects, and use of best available information will ensure future conservation efforts that offer the greatest long-term benefit to sustain bull trout and their required coldwater habitats (USFWS 2015, p. vii, and pp. 17-20, USFWS 2015a-f).

Global climate change and the related warming of global climate have been well documented (IPCC 2007, entire; ISAB 2007, entire; Combes 2003, entire). Evidence of global climate change/warming includes widespread increases in average air and ocean temperatures and accelerated melting of glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (IPCC 2007, p. 253; Battin et al. 2007, p. 6720), we can no longer assume that climate conditions in the future will resemble those in the past.

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (ISAB 2007, entire; Hari et al. 2006, entire; Rieman et al. 2007, entire). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (Magnuson et al. 2000, p. 1743). The range of many species has shifted poleward and elevationally upward. For cold-water associated salmonids in mountainous regions, where their upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in range, which in turn can lead to a population decline (Hari et al. 2006, entire).

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas. Higher air temperatures are also

likely to increase water temperatures (ISAB 2007, pp. 15-17). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers.

Climate change has the potential to profoundly alter the aquatic ecosystems upon which the bull trout depends via alterations in water yield, peak flows, and stream temperature, and an increase in the frequency and magnitude of catastrophic wildfires in adjacent terrestrial habitats (Bisson et al. 2003, pp 216-217).

All life stages of the bull trout rely on cold water. Increasing air temperatures are likely to impact the availability of suitable cold water habitat. For example, ground water temperature is generally correlated with mean annual air temperature, and has been shown to strongly influence the distribution of other chars. Ground water temperature is linked to bull trout selection of spawning sites, and has been shown to influence the survival of embryos and early juvenile rearing of bull trout (Baxter 1997, p. 82). Increases in air temperature are likely to be reflected in increases in both surface and groundwater temperatures.

Climate change is likely to affect the frequency and magnitude of fires, especially in warmer drier areas such as are found on the eastside of the Cascade Mountains. Bisson et al. (2003, pp. 216-217) note that the forest that naturally occurred in a particular area may or may not be the forest that will be responding to the fire regimes of an altered climate. In several studies related to the effect of large fires on bull trout populations, bull trout appear to have adapted to past fire disturbances through mechanisms such as dispersal and plasticity. However, as stated earlier, the future may well be different than the past and extreme fire events may have a dramatic effect on bull trout and other aquatic species, especially in the context of continued habitat loss, simplification and fragmentation of aquatic systems, and the introduction and expansion of exotic species (Bisson et al. 2003, pp. 218-219).

Migratory bull trout can be found in lakes, large rivers and marine waters. Effects of climate change on lakes are likely to impact migratory adfluvial bull trout that seasonally rely upon lakes for their greater availability of prey and access to tributaries. Climate-warming impacts to lakes will likely lead to longer periods of thermal stratification and coldwater fish such as adfluvial bull trout will be restricted to these bottom layers for greater periods of time. Deeper thermoclines resulting from climate change may further reduce the area of suitable temperatures in the bottom layers and intensify competition for food (Shuter and Meisner 1992. p. 11).

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change are related to shifts in timing, magnitude and distribution of peak flows that are also likely to be most pronounced in these high elevation stream basins (Battin et al. 2007, p. 6720). The increased magnitude of winter peak flows in high elevation areas is likely to impact the location, timing, and success of spawning and incubation for the bull trout and Pacific

salmon species. Although lower elevation river reaches are not expected to experience as severe an impact from alterations in stream hydrology, they are unlikely to provide suitably cold temperatures for bull trout spawning, incubation and juvenile rearing.

As climate change progresses and stream temperatures warm, thermal refugia will be critical to the persistence of many bull trout populations. Thermal refugia are important for providing bull trout with patches of suitable habitat during migration through or to make feeding forays into areas with greater than optimal temperatures.

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007, p 7) although the scale of that variation may exceed that of States. For example, several studies indicate that climate change has the potential to impact ecosystems in nearly all streams throughout the State of Washington (ISAB 2007, p. 13; Battin et al. 2007, p. 6722; Rieman et al. 2007, pp. 1558-1561). In streams and rivers with temperatures approaching or at the upper limit of allowable water temperatures, there is little if any likelihood that bull trout will be able to adapt to or avoid the effects of climate change/warming. There is little doubt that climate change is and will be an important factor affecting bull trout distribution. As its distribution contracts, patch size decreases and connectivity is truncated, bull trout populations that may be currently connected may face increasing isolation, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman et al. 2007, pp. 1559-1560). Due to variations in land form and geographic location across the range of the bull trout, it appears that some populations face higher risks than others. Bull trout in areas with currently degraded water temperatures and/or at the southern edge of its range may already be at risk of adverse impacts from current as well as future climate change.

The ability to assign the effects of gradual global climate change to bull trout or to a specific location on the ground is beyond our technical capabilities at this time.

Conservation

<u>*Conservation Needs*</u>

The 2015 recovery plan for bull trout established the primary strategy for recovery of bull trout in the coterminous United States: 1) conserve bull trout so that they are geographically widespread across representative habitats and demographically stable1 in six recovery units; 2) effectively manage and ameliorate the primary threats in each of six recovery units at the core area scale such that bull trout are not likely to become endangered in the foreseeable future; 3) build upon the numerous and ongoing conservation actions implemented on behalf of bull trout since their listing in 1999, and improve our understanding of how various threat factors potentially affect the species; 4) use that information to work cooperatively with our partners to design, fund, prioritize,

and implement effective conservation actions in those areas that offer the greatest long-term benefit to sustain bull trout and where recovery can be achieved; and 5) apply adaptive management principles to implementing the bull trout recovery program to account for new information (USFWS 2015, p. v.).

Information presented in prior draft recovery plans published in 2002 and 2004 (USFWS 2002a, 2004) have served to identify recovery actions across the range of the species and to provide a framework for implementing numerous recovery actions by our partner agencies, local working groups, and others with an interest in bull trout conservation.

The 2015 recovery plan (USFWS 2015) integrates new information collected since the 1999 listing regarding bull trout life history, distribution, demographics, conservation successes, etc., and integrates and updates previous bull trout recovery planning efforts across the range of the single DPS listed under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

The Service has developed a recovery approach that: 1) focuses on the identification of and effective management of known and remaining threat factors to bull trout in each core area; 2) acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time; and 3) identifies and focuses recovery actions in those areas where success is likely to meet our goal of ensuring the certainty of conservation of genetic diversity, life history features, and broad geographical representation of remaining bull trout populations so that the protections of the Act are no longer necessary (USFWS 2015, p. 45-46).

To implement the recovery strategy, the 2015 recovery plan establishes categories of recovery actions for each of the six Recovery Units (USFWS 2015, p. 50-51):

1. Protect, restore, and maintain suitable habitat conditions for bull trout.
2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity.
3. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
4. Work with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change.

Bull trout recovery is based on a geographical hierarchical approach. Bull trout are listed as a single DPS within the five-state area of the coterminous United States. The single DPS is subdivided into six biologically-based recover units: 1) Coastal Recovery Unit; 2) Klamath Recovery Unit; 3) Mid-Columbia Recovery Unit; 4) Upper Snake Recovery Unit; 5) Columbia Headwaters Recovery Unit; and 6) Saint Mary Recovery Unit (USFWS 2015, p. 23). A viable recovery unit should demonstrate that the three primary principles of biodiversity have been met: representation (conserving the genetic makeup

of the species); resiliency (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to withstand catastrophic events) (USFWS 2015, p. 33).

Each of the six recovery units contain multiple bull trout core areas, 116 total, which are non-overlapping watershed-based polygons, and each core area includes one or more local populations. Currently there are 109 occupied core areas, which comprise 611 local populations (USFWS 2015, p. 3). There are also six core areas where bull trout historically occurred but are now extirpated, and one research needs area where bull trout were known to occur historically, but their current presence and use of the area are uncertain (USFWS 2015, p. 3). Core areas can be further described as complex or simple (USFWS 2015, p. 3-4). Complex core areas contain multiple local bull trout populations, are found in large watersheds, have multiple life history forms, and have migratory connectivity between spawning and rearing habitat and FMO habitats. Simple core areas are those that contain one bull trout local population. Simple core areas are small in scope, isolated from other core areas by natural barriers, and may contain unique genetic or life history adaptations.

A local population is a group of bull trout that spawn within a particular stream or portion of a stream system (USFWS 2015, p. 73). A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (e.g., those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

Recovery Units and Local Populations

The final recovery plan (USFWS 2015) designates six bull trout recovery units as described above. These units replace the 5 interim recovery units previously identified (USFWS 1999). The Service will address the conservation of these final recovery units in our section 7(a)(2) analysis for proposed Federal actions. The recovery plan (USFWS 2015), identified threats and factors affecting the bull trout within these units. A detailed description of recovery implementation for each recovery unit is provided in separate recovery unit implementation plans (RUIPs)(USFWS 2015a-f), which identify conservation actions and recommendations needed for each core area, forage/ migration/ overwinter areas, historical core areas, and research needs areas. Each of the following recovery units (below) is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

Coastal Recovery Unit

The coastal recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015a). The Coastal Recovery Unit is located within western Oregon and Washington. The Coastal Recovery Unit is divided into three regions: Puget Sound, Olympic Peninsula, and the Lower Columbia River Regions. This recovery unit contains 20 core areas comprising 84 local

populations and a single potential local population in the historic Clackamas River core area where bull trout had been extirpated and were reintroduced in 2011, and identified four historically occupied core areas that could be re-established (USFWS 2015, pg. 47; USFWS 2015a, p. A-2). Core areas within Puget Sound and the Olympic Peninsula currently support the only anadromous local populations of bull trout. This recovery unit also contains ten shared FMO habitats which are outside core areas and allows for the continued natural population dynamics in which the core areas have evolved (USFWS 2015a, p. A-5). There are four core areas within the Coastal Recovery Unit that have been identified as current population strongholds: Lower Skagit, Upper Skagit, Quinault River, and Lower Deschutes River (USFWS 2015, p.79). These are the most stable and abundant bull trout populations in the recovery unit. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, loss of functioning estuarine and nearshore marine habitats, development and related impacts (e.g., flood control, floodplain disconnection, bank armoring, channel straightening, loss of instream habitat complexity), agriculture (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation, livestock grazing), fish passage (e.g., dams, culverts, instream flows) residential development, urbanization, forest management practices (e.g., timber harvest and associated road building activities), connectivity impairment, mining, and the introduction of non-native species. Conservation measures or recovery actions implemented include relicensing of major hydropower facilities that have provided upstream and downstream fish passage or complete removal of dams, land acquisition to conserve bull trout habitat, floodplain restoration, culvert removal, riparian revegetation, levee setbacks, road removal, and projects to protect and restore important nearshore marine habitats.

Klamath Recovery Unit

The Klamath recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015b). The Klamath Recovery Unit is located in southern Oregon and northwestern California. The Klamath Recovery Unit is the most significantly imperiled recovery unit, having experienced considerable extirpation and geographic contraction of local populations and declining demographic condition, and natural re-colonization is constrained by dispersal barriers and presence of nonnative brook trout (USFWS 2015, p. 39). This recovery unit currently contains three core areas and eight local populations (USFWS 2015, p. 47; USFWS 2015b, p. B-1). Nine historic local populations of bull trout have become extirpated (USFWS 2015b, p. B-1). All three core areas have been isolated from other bull trout populations for the past 10,000 years (USFWS 2015b, p. B-3. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, nonnative species, and past fisheries management practices. Conservation measures or recovery actions implemented include removal of nonnative fish (e.g., brook trout, brown trout, and hybrids), acquiring water rights for instream flows, replacing diversion structures, installing fish screens, constructing bypass channels, installing riparian fencing, culver replacement, and habitat restoration.

Mid-Columbia Recovery Unit

The Mid-Columbia recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015c). The Mid-Columbia Recovery Unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. The Mid-Columbia Recovery Unit is divided into four geographic regions: Lower Mid-Columbia, Upper Mid-Columbia, Lower Snake, and Mid-Snake Geographic Regions. This recovery unit contains 24 occupied core areas comprising 142 local populations, two historically occupied core areas, one research needs area, and seven FMO habitats (USFWS 2015, pg. 47; USFWS 2015c, p. C-1–4). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, agricultural practices (e.g. irrigation, water withdrawals, livestock grazing), fish passage (e.g. dams, culverts), nonnative species, forest management practices, and mining. Conservation measures or recovery actions implemented include road removal, channel restoration, mine reclamation, improved grazing management, removal of fish barriers, and instream flow requirements.

Columbia Headwaters Recovery Unit

The Columbia headwaters recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015d, entire). The Columbia Headwaters Recovery Unit is located in western Montana, northern Idaho, and the northeastern corner of Washington. The Columbia Headwaters Recovery Unit is divided into five geographic regions: Upper Clark Fork, Lower Clark Fork, Flathead, Kootenai, and Coeur d'Alene Geographic Regions (USFWS 2015d, pp. D-2 – D-4). This recovery unit contains 35 bull trout core areas; 15 of which are complex core areas as they represent larger interconnected habitats and 20 simple core areas as they are isolated headwater lakes with single local populations. The 20 simple core areas are each represented by a single local population, many of which may have persisted for thousands of years despite small populations and isolated existence (USFWS 2015d, p. D-1). Fish passage improvements within the recovery unit have reconnected some previously fragmented habitats (USFWS 2015d, p. D-1), while others remain fragmented. Unlike the other recovery units in Washington, Idaho and Oregon, the Columbia Headwaters Recovery Unit does not have any anadromous fish overlap. Therefore, bull trout within the Columbia Headwaters Recovery Unit do not benefit from the recovery actions for salmon (USFWS 2015d, p. D-41). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, mostly historical mining and contamination by heavy metals, expanding populations of nonnative fish predators and competitors, modified instream flows, migratory barriers (e.g., dams), habitat fragmentation, forest practices (e.g., logging, roads), agriculture practices (e.g. irrigation, livestock grazing), and residential development. Conservation measures or recovery actions implemented include habitat improvement, fish passage, and removal of nonnative species.

Upper Snake Recovery Unit

The Upper Snake recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015e, entire). The Upper Snake Recovery Unit is located in central Idaho, northern Nevada,

and eastern Oregon. The Upper Snake Recovery Unit is divided into seven geographic regions: Salmon River, Boise River, Payette River, Little Lost River, Malheur River, Jarbidge River, and Weiser River. This recovery unit contains 22 core areas and 207 local populations (USFWS 2015, p. 47), with almost 60 percent being present in the Salmon River Region. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, dams, mining, forest management practices, nonnative species, and agriculture (e.g., water diversions, grazing). Conservation measures or recovery actions implemented include instream habitat restoration, instream flow requirements, screening of irrigation diversions, and riparian restoration.

St. Mary Recovery Unit

The St. Mary recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015f). The Saint Mary Recovery Unit is located in Montana but is heavily linked to downstream resources in southern Alberta, Canada. Most of the Saskatchewan River watershed which the St. Mary flows into is located in Canada. The United States portion includes headwater spawning and rearing habitat and the upper reaches of FMO habitat. This recovery unit contains four core areas, and seven local populations (USFWS 2015f, p. F-1) in the U.S. Headwaters. The current condition of the bull trout in this recovery unit is attributed primarily to the outdated design and operations of the Saint Mary Diversion operated by the Bureau of Reclamation (e.g., entrainment, fish passage, instream flows), and, to a lesser extent habitat impacts from development and nonnative species.

Tribal Conservation Activities

Many Tribes throughout the range of the bull trout are participating on bull trout conservation working groups or recovery teams in their geographic areas of interest. Some tribes are also implementing projects which focus on bull trout or that address anadromous fish but benefit bull trout (e.g., habitat surveys, passage at dams and diversions, habitat improvement, and movement studies).

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APPENDIX E: STATUS OF THE SPECIES: BULL TROUT CRITICAL HABITAT

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Appendix E
Status ofSpecies: Bull Trout Critical Habitat

Past designations of critical habitat have used the terms "primary constituent elements" (PCEs), “physical and biological features” (PBFs) or "essential features" to characterize the key components of critical habitat that provide for the conservation of the listed species. The new critical habitat regulations (81 FR 7214) discontinue use of the terms “PCEs” or “essential features” and rely exclusively on use of the term PBFs for that purpose because that term is contained in the statute. To be consistent with that shift in terminology and in recognition that the terms PBFs, PCEs, and essential habit features are synonymous in meaning, we are only referring to PBFs herein. Therefore, if a past critical habitat designation defined essential habitat features or PCEs, they will be referred to as PBFs in this document. This does not change the approach outlined above for conducting the ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs or essential features.

Current Legal Status of the Critical Habitat

Current Designation

The U.S. Fish and Wildlife Service (Service) published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (USFWS 2010, entire); the rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on the Service’s website: (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species’ coterminous range, which includes the Coastal, Klamath, Mid-Columbia, Upper Snake, Columbia Headwaters and St. Mary’s Recovery Unit population segments. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat (Table 1). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) foraging, migration, and overwintering (FMO).

Table 1. Stream/Shoreline Distance and Reservoir/Lake Area Designated as Bull Trout Critical Habitat.

State	Stream/Shoreline Miles	Stream/Shoreline Kilometers	Reservoir/Lake Acres	Reservoir/Lake Hectares
Idaho	8,771.6	14,116.5	170,217.5	68,884.9
Montana	3,056.5	4,918.9	221,470.7	89,626.4
Nevada	71.8	115.6	-	-
Oregon[1]	2,835.9	4,563.9	30,255.5	12,244.0
Oregon/Idaho[2]	107.7	173.3	-	-
Washington	3,793.3	6,104.8	66,308.1	26,834.0
Washington (marine)	753.8	1,213.2	-	-
Washington/Idaho	37.2	59.9	-	-
Washington/Oregon	301.3	484.8	-	-
Total[3]	19,729.0	31,750.8	488,251.7	197,589.2

[1] No shore line is included in Oregon
[2] Pine Creek Drainage which falls within Oregon
[3] Total of freshwater streams: 18,975

The 2010 revision increases the amount of designated bull trout critical habitat by approximately 76 percent for miles of stream/shoreline and by approximately 71 percent for acres of lakes and reservoirs compared to the 2005 designation.

The final rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. No unoccupied habitat was included in the 2005 designation. These unoccupied areas were determined by the Service to be essential for restoring functioning migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower main stem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. 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 section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), 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 that inclusion would impair their relationship with the Service; or 3) waters where impacts to national security have been identified (USFWS 2010, p. 63903). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant Critical Habitat Unit (CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

The Physical and Biological Features

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (USFWS 2010, p. 63898). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. 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.

Thirty-two CHUs within the geographical area occupied by the species at the time of listing are designated under the revised rule. Twenty-nine of the CHUs contain all of the physical or biological features identified in this final rule and support multiple life-history requirements. Three of the mainstem river units in the Columbia and Snake River Basins contain most of the

physical or biological features necessary to support the bull trout's particular use of that habitat, other than those physical biological features associated with physical and biological features (PBFs) 5 and 6, which relate to breeding habitat.

The primary function of individual CHUs is to maintain and support core areas, which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-315; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

Physical and Biological Features for Bull Trout

Within the designated critical habitat areas, the PBFs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Based on our current knowledge of the life history, biology, and ecology of this species and the characteristics of the habitat necessary to sustain its essential life-history functions, we have determined that the PBFs, as described within USFWS 2010, are essential for the conservation of bull trout. A summary of those PBFs follows.

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.
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.
3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
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.
5. Water temperatures ranging from 2 °C to 15 °C, 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.

6. 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.
7. 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.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

The revised PBF's are similar to those previously in effect under the 2005 designation. The most significant modification is the addition of a ninth PBF to address the presence of nonnative predatory or competitive fish species. Although this PBF applies to both the freshwater and marine environments, currently no non-native fish species are of concern in the marine environment, though this could change in the future.

Note that only PBFs 2, 3, 4, 5, and 8 apply to marine nearshore waters identified as critical habitat. Also, lakes and reservoirs within the CHUs also contain most of the physical or biological features necessary to support bull trout, with the exception of those associated with PBFs 1 and 6. Additionally, all except PBF 6 apply to FMO habitat designated as critical habitat.

Critical habitat includes the stream channels within the designated stream reaches and has a lateral extent as defined by the bankfull elevation on one bank to the bankfull elevation on the opposite bank. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. If bankfull elevation is not evident on either bank, the ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The Service assumes in many cases this is the full-pool level of the waterbody. In areas where only one side of the waterbody is designated (where only one side is excluded), the mid-line of the waterbody represents the lateral extent of critical habitat.

In marine nearshore areas, the inshore extent of critical habitat is the mean higher high-water (MHHW) line, including the uppermost reach of the saltwater wedge within tidally influenced freshwater heads of estuaries. The MHHW line refers to the average of all the higher high-water heights of the two daily tidal levels. Marine critical habitat extends offshore to the depth of 10 meters (m) (33 ft) relative to the mean low low-water (MLLW) line (zero tidal level or average of all the lower low-water heights of the two daily tidal levels). This area between the MHHW

line and minus 10 m MLLW line (the average extent of the photic zone) is considered the habitat most consistently used by bull trout in marine waters based on known use, forage fish availability, and ongoing migration studies and captures geological and ecological processes important to maintaining these habitats. This area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Adjacent shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by no longer serving the intended conservation role for the species or retaining those PBFs that relate to the ability of the area to at least periodically support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PBFs to such an extent that the conservation value of critical habitat is appreciably reduced (USFWS 2010, pp. 63898:63943; USFWS 2004a, pp. 140-193; USFWS 2004b, pp. 69-114). The Service's evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998, Ch. 4 p. 39). Thus, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (USFWS 2010, pp. 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (USFWS 2010, pp. 63898:63943).

Current Critical Habitat Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (Ratliff and Howell 1992, entire; Schill 1992, p. 40; Thomas 1992, p. 28; Buchanan et al. 1997, p. vii; Rieman et al. 1997, pp. 15-16; Quigley and Arbelbide 1997, pp. 1176-1177). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (USFWS 1998, pp. 31648-31649; USFWS 1999, p. 17111).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PBFs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have

eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final rule was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features described in PBFs 1, 2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes).

Many of the PBFs for bull trout may be affected by the presence of toxics and/or increased water temperatures within the environment. The effects will vary greatly depending on a number of factors which include which toxic substance is present, the amount of temperature increase, the likelihood that critical habitat would be affected (probability), and the severity and intensity of any effects that might occur (magnitude).

The ability to assign the effects of gradual global climate change bull trout critical habitat or to a specific location on the ground is beyond our technical capabilities at this time.

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