# United States Department of the Interior

FISH AND WILDLIFE SERVICE

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


SEP 21 2016

In Reply Refer To:
**01EWFW00-2015-F-1006**

Captain T.A. Zwolfer
Naval Base Kitsap
ATTN: Tiffany Nabors
120 South Dewey St.
Bremerton, Washington 98314-5020

Dear Captain Zwolfer:

Subject: Pier and Support Facilities for the Transit Protection System at U.S. Coast Guard Air Station/Sector Field Office, Port Angeles, Washington

This letter transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) on the U.S. Navy's (Navy) Transit Protection System Project, and its effects on the marbled murrelet (*Brachyramphus marmoratus*), bull trout (*Salvelinus confluentus*), and designated bull trout critical habitat. The project involves the construction of a new pier and housing facility for U.S. Coast Guard personnel on Ediz Hook in Port Angeles, Clallam County, Washington. Formal consultation on the proposed action was conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.). Your September 30, 2015, request for formal consultation was received on September 30, 2015.

The enclosed Biological Opinion is based on information provided in the September, 2015, Biological Assessment, telephone conversations, emails, and other sources of information cited in the Biological Opinion. A complete record of this consultation is on file at the Service's Washington Fish and Wildlife Office in Lacey, Washington.

If you have any questions about the enclosed Opinion, or our joint responsibilities under the Endangered Species Act, please contact Jim Muck (360) 753-9586 or Martha Jensen (360) 753-9000, of this office.

Sincerely,

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

Enclosure(s)

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Endangered Species Act - Section 7 Consultation

# BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference Number:
**01EWFW00-2015-F-1006**

## Pier and Support Facilities for the Transit Protection System

## Clallam County, Washington

| | |
|---|---|
| Action Agency: | U.S. Navy<br>Naval Base Kitsap |
| Consultation Conducted By: | U.S. Fish and Wildlife Service<br>Washington Fish and Wildlife Office |

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

Date 9/21/16

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## ACROYNMS AND ABBREVIATIONS

| | |
|---|---|
| AIRSTA/SFO | Air Station/Sector Field Office |
| CFR | Code of Federal Regulations |
| dB | decibel |
| dBA | A-weighted decibel level |
| $dB_{RMS}$ | Root Mean Squared |
| ESA | Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) |
| FR | Federal Register |
| ft | feet |
| GHG | greenhouse gas |
| IPCC | Intergovernmental Panel on Climate Change |
| MHHW | mean higher high water |
| MLLW | mean lower low-water |
| Navy | U.S. Navy |
| Opinion | Biological Opinion |
| PBF | Physical or Biological Features |
| PCE | Primary Constituent Element |
| RPM | Reasonable and Prudent Measures |
| SEL | Sound Exposure Level |
| Service | U.S. Fish and Wildlife Service |
| SPL | Sound Pressure Levels |
| TL | Transmission Loss |
| TPS | Transit Protection System |
| USCG | U.S. Coast Guard |

## INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) based on our review of the U.S. Navy's (Navy) proposed Pier and Support Facilities for the Transit Protection System (TPS) Project located in Clallam County, Washington, and its effects on the marbled murrelet (*Brachyramphus marmoratus*), bull trout (*Salvelinus confluentus*), and designated bull trout critical habitat. This consultation has been conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.) (ESA). Your September 30, 2015, request for formal consultation was received on September 30, 2015.

This Opinion is based on information provided in the September 2015, Biological Assessment, telephone conversations, emails, and other sources of information. A complete record of this consultation is on file at the Service's Washington Fish and Wildlife Office in Lacey, Washington.

## CONSULTATION HISTORY

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

- On September 30, 2015, the Navy sent the Service a request for formal consultation with an effect determination of "may affect, likely to adversely affect" for the marbled murrelet, bull trout, and bull trout critical habitat.

- Formal consultation was initiated on September 30, 2015.

- On March 9, 2016, the Service sent a letter to the Navy requesting a 60-day extension to the consultation due to the Navy's Northwest Training and Testing Activities consultation which the Navy requested to be a higher priority than the TPS Project. The Service stated that we may not be able to complete the consultation within the 60-day time extension because of current work backlog and priorities.

- On April 22, May 4, June 29, 2016, and July 5, 2016, the Service requested additional information on the project via email and during phone conversations. Information requested concerned: 1) current location of vessels to be moored at the pier, 2) stormwater discharge, 3) sewer tank discharge, 4) artificial lighting, 5) upland pile installation, 6) marbled murrelet monitoring during pile driving, 7) net pen relocation, 8) piles for mooring dolphins, 9) number of falsework/indicator piles to be installed, 10) eelgrass and project mitigation, and 11) size of the catwalks.

- The Navy responded to these additional information requests on April 28, May 12, May 18, June 30, and July 5, 2016.

- On August 11, 2016, the Service sent a draft copy of the Opinion to the Navy.

- On August 12, 2016, the Navy requested a copy of the Service's hydroacoustic monitoring protocol. The Service provided the protocol on August 15, 2016.

- On August 17, 2016, the Navy provided comments on the draft Opinion.

# 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).

The Navy is proposing to construct a staging location for up to seven TPS vessels and crews that escort Navy submarines to and from the dive/surface points in the Strait of Juan de Fuca and Naval Base Kitsap Bangor. The project's in-water work involves installing an approach trestle, a new pier, two mooring dolphins, three floats, catwalks, and walkways (Figure 1). Upland work includes the construction of a new building that will provide sleeping accommodations and administrative office space; an ammunition and small arms storage facility; diesel fuel, marine storage tank, and distribution system; and site improvements that include utilities, parking, waste and stormwater treatment, security improvements, lighting, and landscaping. In-water work includes the installation of 144 permanent 18-inch to 36-inch diameter steel piles and eighty 24-inch temporary indicator or falsework steel piles. The project will result in 25,465 square feet (0.6 acre) of new overwater structures and may require two in-water work windows to complete.

Specific project activities that may affect marbled murrelets and bull trout include:

- Installation of the new approach trestle, fixed pier, mooring dolphins, and floats. The trestle will be approximately 335 ft long and 24 ft wide and constructed of precast concrete. The trestle will be supported by sixteen 18-inch, twelve 24-inch, and eight 36-inch diameter steel piles. The trestle will connect to three steel piles and 60 sheet piles installed on shore. Installation of the permanent support piles is expected to take approximately 75 days.

  The fixed pier will be installed at the end of the trestle, will be constructed of precast concrete, and will measure approximately 160 ft long by 42 ft wide. The fixed pier will be supported by twenty-eight 24-inch, thirty-nine 30-inch, and ten 36-inch diameter piles and will be constructed at water depth between -45 ft and -63 ft mean lower low-water (MLLW).

  Two mooring dolphins will be connected to the fixed pier by catwalks. Each of the mooring dolphins will be constructed of five 30-inch diameter piles. The catwalks will be approximately 50 ft long by 4.5 ft wide and 72 ft long by 4.5 ft wide for the west and east mooring dolphins, respectively.

Three floats will be constructed, two on the west side of the fixed pier and one on the east side. The floats will be connected to each other or the fixed pier by walkways and transfer spans. Each float on the west side will be 80 ft long by 17 ft wide and the float on the east side will be 120 ft by 12 ft. The floats will be supported by three 24-inch, six 30-inch, and twelve 36-inch piles. The catwalks will be approximately 70 ft long by 5.5 ft wide and 60 ft long by 5.5 ft wide and will be located to the west and east of the floats, respectively.

- Installation of eighty 24-inch diameter indicator or falsework piles for temporary work platforms. These temporary indicator or test piles will be installed with a vibratory pile driver, proofed to refusal and removed. Installation and removal of the temporary piles will be conducted during the first in-water work window and will take approximately 25 days.

- The fixed approach trestle and fixed pier would be sloped to capture stormwater at low points in the deck. Stormwater would drain to a basic treatment device, designed to remove 80 percent of total suspended solids from influent prior to being released directly into Port Angeles Harbor.

**Mitigation**

The Navy is coordinating with the U.S. Army Corps of Engineers to identify and develop compensatory mitigation for the loss of aquatic resources and shading. The Navy is also working with the Lower Elwha Klallam Tribe to identify and develop mitigation for impacts to treaty reserved rights and resources. The anticipated mitigation projects include the following elements (Figure 2):

1. Inner Ediz Hook Jetty Restoration (Compensatory Mitigation) – Involves the removal of 16,800 square feet of fill located in shallow aquatic tidelands along the southern shoreline of Ediz Hook east of the entrance gate to the U.S. Coast Guard (USCG) Air Station/Sector Field Office (AIRSTA/SFO) Port Angeles and Puget Sound Pilots Station pier. The fill currently extends approximately 215 feet (ft) south from the shoreline and is protected by a timber bulkhead capped by a concrete slab. The timber piles comprising the bulkhead would be cut off and capped below the mudline.

2. Icicle Seafoods Laydown Area Restoration (mitigation for impacts to reserved treaty rights and tribal trust resources) – Involves the removal of an additional 18,980 square feet of fill in aquatic tidelands along the southern shoreline of inner Ediz Hook adjacent to and west of the public boat launch on Ediz Hook Boat.

In addition, as a result of Government-to-Government consultation with the Port Gamble S'Klallam, Jamestown S'Klallam, and Lower Elwha Klallam Tribes, the Navy has agreed to examine the feasibility of salvaging eelgrass from the planned TPS pier footprint and transplanting it to nearby shallow subtidal restoration sites along Ediz Hook. If the transplant is determined feasible, the Navy will enter into a Cooperative Agreement under the Sikes Act with the Lower Elwha Klallam Tribe to perform the work with Navy funds.

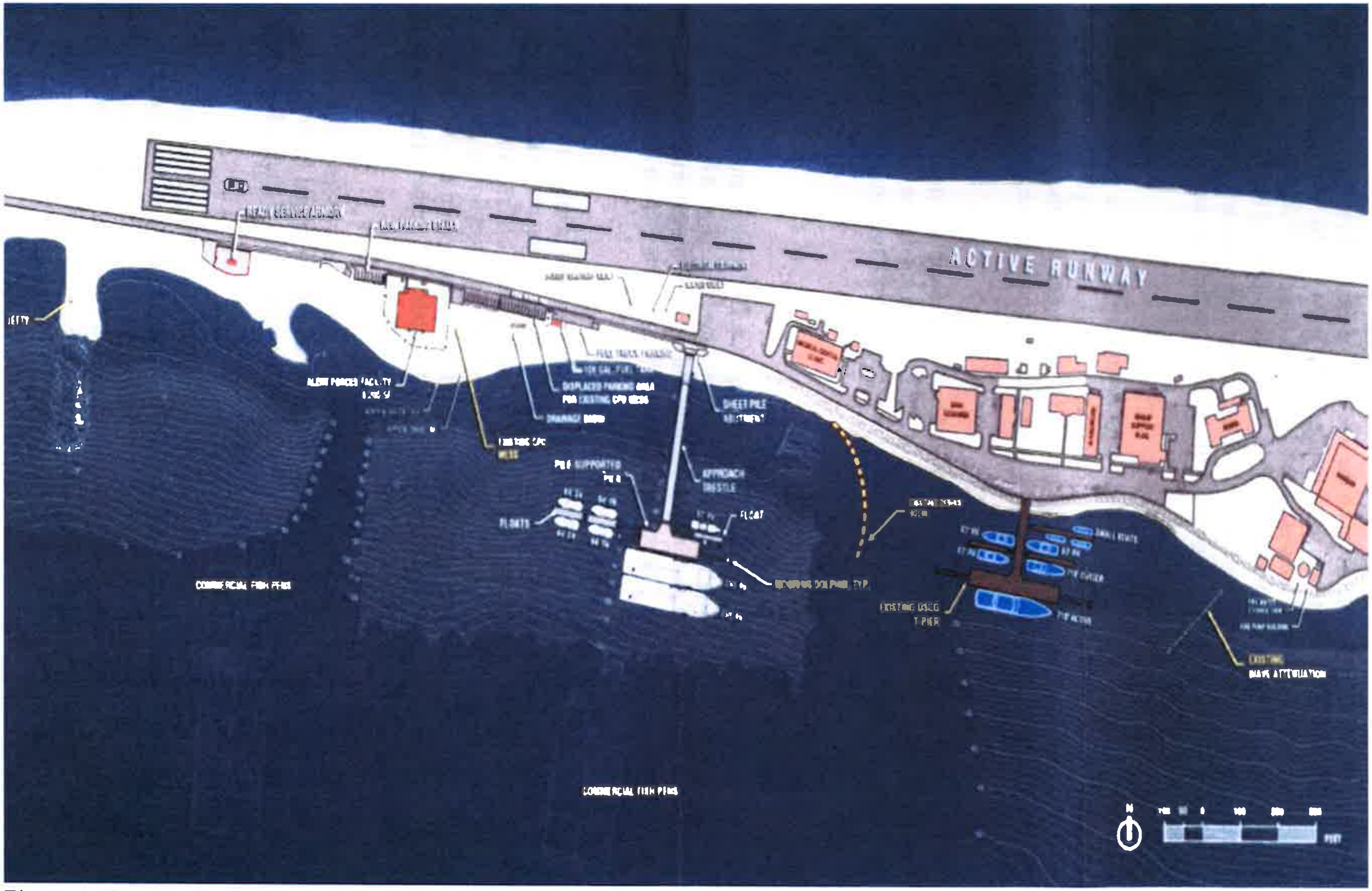


Figure 1.  Proposed project construction activities.

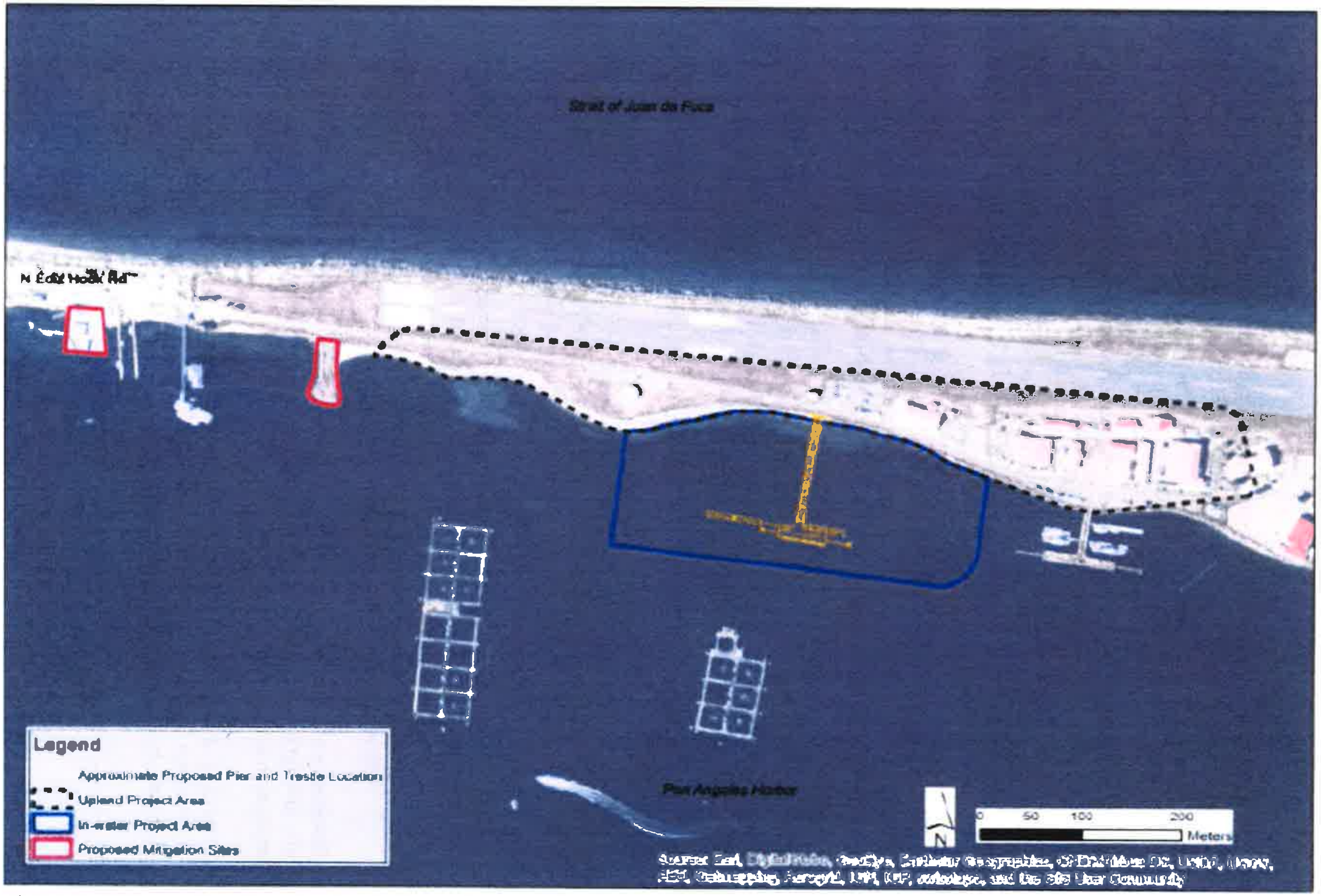


Figure 2. Project mitigation sites in relation to the project area.

**Conservation Measures**

Conservation measures are actions that would minimize impacts to listed species that are included as an integral part of the proposed action. The conservation measures for this project are provided on pages 13-16 of the Biological Assessment. Specific conservation measures that will minimize impacts to bull trout and the marbled murrelets include:

1. Working during the approved in-water work window for Tidal Reference Area 10 (July 16 to February 15). The project is expected to take two work windows to complete.

2. Employing a bubble curtain that meets Service approved specifications for all steel piles that will be installed with an impact hammer to reduce the transmission of underwater sound pressure levels (SPLs).

3. Impact pile driving conducted between July 16 and September 23 will occur between two hours after sunrise to two hours before sunset (primary feeding times) to minimize impacts to foraging marbled murrelets that may be provisioning young.

4. Conducting hydroacoustic monitoring on a subset of impact pile driving activities. Hydroacoustic monitoring will be conducted on 5 to 10 piles of different sizes and at different depths, according to the attached hydroacoustic monitoring protocol, to verify that SPLs levels provided and analyzed in this consultation are not exceeded.

5. Implementing a marbled murrelet monitoring protocol during all in-water impact pile driving of steel piles:
    a. To detect marbled murrelets within the 92 meter (m) zone where onset of physical injury or mortality may occur. If marbled murrelets are detected within 92 m of these pile installations, pile driving will stop and will not resume until the birds have volitionally left the area.
    b. To detect marbled murrelets beyond the 92 m zone where masking may occur (extending to 168 m when impact driving 36-inch diameter steel piles). If marbled murrelets are detected from stationary monitoring locations in the masking zone (between 92 m and 168 m) of these pile installations, pile driving will stop and will not resume until the birds have volitionally left the area.

6. Installing a silt curtain to control the spread of turbidity and suspended sediments during pile driving activities and removal of fill material in the nearshore area (at the two mitigation sites).

7. Removing an imported-fill laydown area located in aquatic tidelands owned by the Washington Department of Natural Resources and associated upland structures to restore intertidal, beach, and nearshore habitat.

**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 elevated underwater SPLs from impact pile driving steel piles, as depicted in Figure 3.

The action area is determined based on the anticipated sound levels generated in the air and in the water during construction, with the analysis emphasizing impact pile driving, which has the greatest potential to cause adverse effects. The farthest reaching effects will be in-water sound from sound created during impact pile driving piles.

The action area includes the project site in Port Angeles Harbor and the distance that in-air sound would propagate until it reaches background levels and in-water sound would propagate until it reaches background levels.

We determined the action area to include:

- In-air effects extending approximately 9.45 miles.
- In-water effects extending approximately 27.8 miles. However, the sound intersects land surrounding Port Angeles Harbor. Maximum distance is approximately 9.2 miles.

*In-Air Sound*

The extent of in-air sound was calculated based on the distance that construction noise would extend until it attenuates to ambient levels (assumes sound reduction of 6 dB per doubling of distance). The loudest activity will be the placement of the steel piles using impact-hammer pile driving. In-air sound is expected to reach 110 dBA peak at a distance of 50 ft during impact pile driving (WSDOT 2015, p. 7.12). The baseline ambient sound levels for the project area are estimated to be approximately 52.1 dBA (Navy 2015, p. 16) because the area is heavily industrialized and vessel traffic is common. Project-related in-air sound is expected to extend 9.45 miles before attenuating to ambient background levels (Figure 3).

*In-Water Sound*

The Service uses the practical spreading model described by Davidson (2004, p.2) [TL=15*Log (R)] to determine the distances at which injury to marbled murrelets and bull trout would be expected. This model assumes that underwater sound decreases at a rate of 4.5 dB per doubling of distance.

In areas where underwater sound exceeds 150 $dB_{RMS}$ we expect there to be potential behavioral responses of fish and diving seabirds from exposure to the elevated levels of underwater sound. Based on the practical spreading model, elevated underwater sound is expected to extend 27.8 miles from impact pile driving locations before attenuating to background levels (124 $dB_{RMS}$) or contacting land. These temporary elevations in underwater sound from impact pile driving are expected to have the farthest reaching effects in the aquatic environment. The extent of in-water sound was calculated based on the distance construction noise (impact pile driving) would travel until the sound either attenuates to background or makes contact with land (Figure 3).

Figure 3. In-air (red) and in-water (green) action areas for the proposed TPS Project (yellow).

## 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**

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 (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. 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 should be viewed as synonymous with PBFs. Either term characterizes the key components of critical habitat that provide for the conservation of the listed species.

Our analysis of effects to 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 in terms of PCEs or PBFs, 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 PCEs or PBFs and how that will 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 PCEs or PBFs and how that will 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 A: 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 B: Status of the Species: Bull Trout.

## STATUS OF CRITICAL HABITAT

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

## ENVIRONMENTAL BASELINE IN THE ACTION AREA

Regulations implementing the ESA (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.

For the purposes of this analysis, we have focused our discussion of the environmental baseline on those portions of the action area where marbled murrelets and bull trout could be measurably affected. Marbled murrelets may forage, breed, and/or loaf (sleep, rest, preen, etc.) in the marine waters of the affected area during any time of year, although we expect their density in marine areas will be higher during the winter months (October through March). Adult and/or subadult bull trout may forage or migrate in the marine waters of the action area during any time of the year.

### Existing Conditions: Setting

The project is located along the southern shoreline of Ediz Hook, approximately 0.8 mile west of the end of the spit, within Port Angeles Harbor. Ediz hook is a naturally formed narrow spit of land, with widths ranging from 90 to 750 ft, and juts 3.6 miles into the Strait of Juan de Fuca, forming the northern boundary of Port Angeles Harbor. The southern shoreline of the Ediz Hook spit is lined with public beaches, picnic spots, parking areas, and a multi-use recreational trail.

The USCG AIRSTA/SFO at Port Angeles is primarily composed of paved roads, parking lots, buildings, and a runway and is located at the eastern tip of the spit. The upland habitat is composed of terrestrial salt-tolerant grasses and shrubs and shore pines planted near the USCG buildings. Beaches occur along Ediz Hook, contain small pea gravel, riprap, and drift wood.

The shoreline of Port Angeles Harbor, just south of Ediz Hook, includes a commercial waterfront, marina, ferry terminal, log yard, the Nippon pulp and paper mill at the western edge of the bay and the abandoned Rayonier mill site near the eastern edge of the action area. There are approximately 20 different overwater structures along the City of Port Angeles' waterfront that can serve as physical barriers or result in dark shadows under the structures that salmonids avoid (Toft et al. 2004; Anchor QEA 2012). Although most of the shoreline is armored, only the western portion within the city limits is developed and affected by overwater structures. The structures include large and small piers and docks, slips, gangways, floats and boats in the marina, and log booms.

Aquatic vegetation is abundant throughout Port Angeles Harbor. Beds of bull kelp (*Nereocystis*) and eelgrass (*Zostera* spp) are both found throughout the action area. The bull kelp is found in areas with bedrock and cobbles in high wave energy areas within shallow waters (typically found at depths less than 66 ft) and is common along the Port Angeles waterfront side of the harbor. Eelgrass is most abundant in low-wave energy areas, including the protected waters along the inside shoreline of Ediz Hook on the northern side of the harbor. It occurs in the lower intertidal and shallow subtidal areas with substrates ranging from mud to clean sand. The depth of eelgrass is typically less than 32 ft limited by light availability. Eelgrass distribution along the Ediz Spit and the project area is shown in Figure 4.

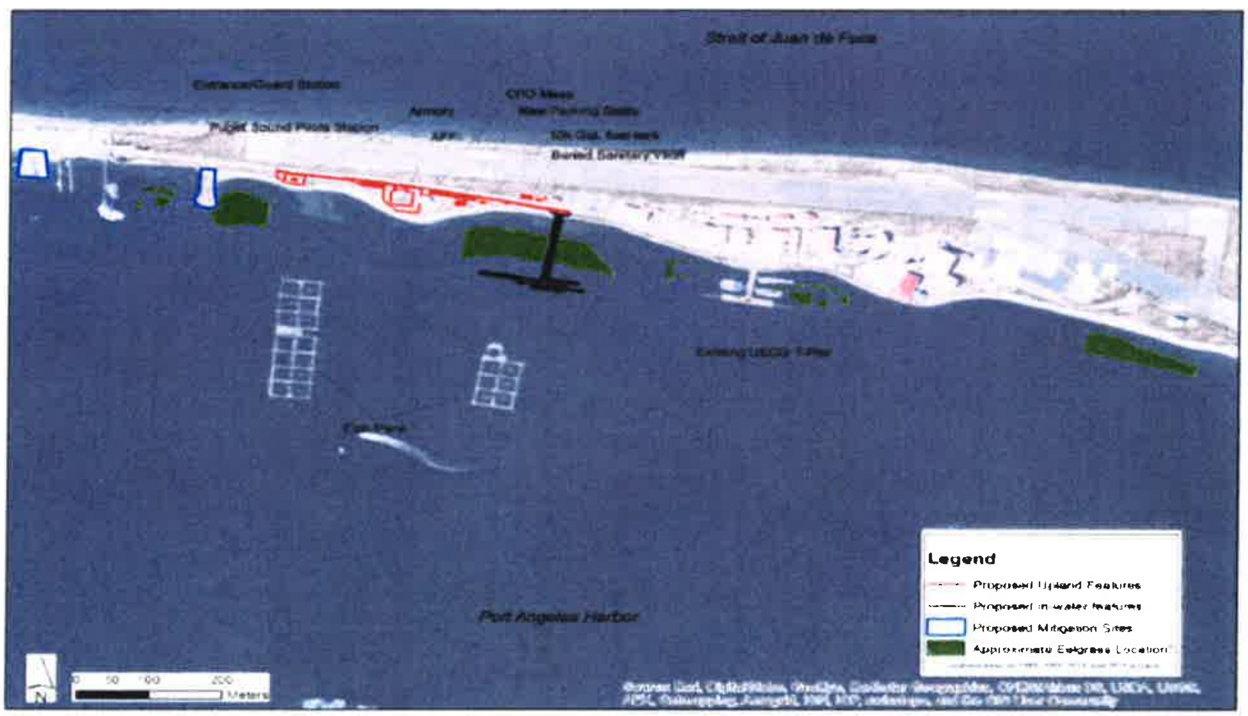

Figure 4. Eelgrass beds located within the project area.

Documented forage fish spawning occurs at several locations within the action area. Pacific sand lance (*Ammodytes hexapterus*) spawning occurs approximately one mile west of the project site (Figure 5). Surf smelt (*Hypomesus pretiosus*) documented spawning occurs over 4.5 miles to the southwest of the project site.

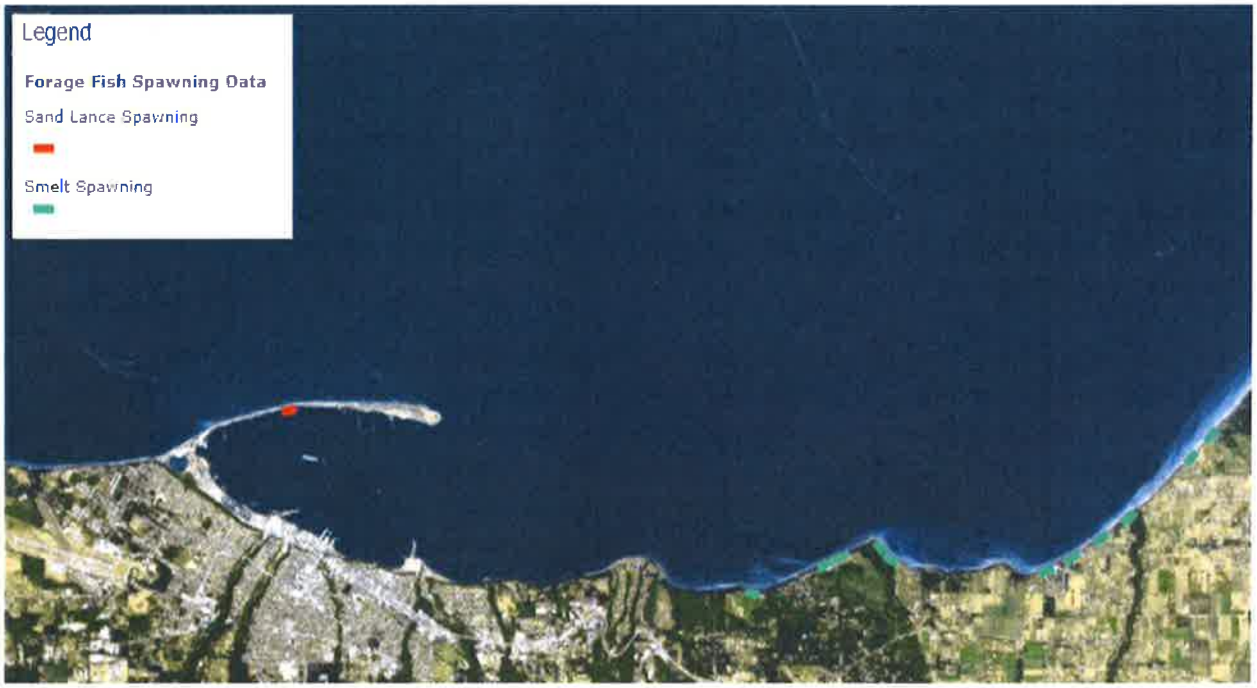

Figure 5. Documented forage fish spawning locations within the action area (WDFW 2016).

**Status of Marbled Murrelet in the Action Area**

The action area provides suitable marine habitat for the marbled murrelet and is known to support moderate to high concentrations of marbled murrelets during both the summer and winter months. Many prey species (e.g., forage fish) for marbled murrelets concentrate in nearshore waters where organisms from lower trophic levels are abundant and serve as food for marbled murrelets (USFWS 1997, p. 30). Marbled murrelets are documented to nest and/or be present in forested environments in several locations within 50 miles of the project area. The action area is used by marbled murrelets for foraging, loafing (resting, preening), courtship behaviors, rearing, and social interactions between adults and/or fledglings. Based on radio telemetry data and at sea monitoring, marbled murrelets use the nearshore areas along the Straits of Juan de Fuca, including the action area, extensively and are expected to be present in moderate to high numbers during and after construction.

**Conservation Role of the Action Area for Marbled Murrelets**

The marine environment plays an essential role in the recovery of marbled murrelets, and protecting the quality of the marine environment has been identified in the recovery plan as an integral part of the recovery effort (USFWS 1997, p. 120). Marbled murrelets are found in relatively high abundance in the nearshore areas of the Strait of Juan de Fuca and the San Juan Islands. These geographic areas are more important for the conservation of the species than the southern areas of Puget Sound. Juvenile salmonids and marine forage fish travel along the nearshore areas of Port Angeles Harbor and Ediz Hook and these prey resources are expected to become more numerous with the removals of the Elwha dams. The conservation role of the action area for marbled murrelets is significant because it provides foraging opportunities in relatively close proximity to suitable nesting habitat on the Olympic Peninsula. The relatively intact shorelines, abundant prey resources, and protected forest environments on the Olympic Peninsula highlight the importance of this area and its conservation role for marbled murrelets in Conservation Zone 1.

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). Hatch (2011, p. 86) suggests that Kittlitz's murrelets (*Brachyramphus brevirostris*) can increase the energy content of prey loads delivered to nestlings by selecting prey with greater density (e.g., selecting species with higher fat content), thereby improving the efficiency of energy provisioning to the nest and decreasing their daily demands. We expect the same would apply to marbled murrelets and that sufficient quantities of forage fish are essential to their survival.

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 populations 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.

**Status of Bull Trout in the Action Area**

The Strait of Juan de Fuca, including the action area and tributaries to Port Angeles Harbor, provides essential foraging, migrating and overwintering habitat for anadromous adult and subadult bull trout. The Strait of Juan de Fuca provides habitat that is crucial for maintaining bull trout life history diversity and access to productive foraging areas. Port Angeles Harbor is located close to two of the Olympic Peninsula Management Unit's larger core areas: the Elwha and Dungeness River Core Areas. See Appendix D for a description of the status of bull trout in the Elwha Core Area and Appendix E for the status of bull trout in the Dungeness Core Area.

We expect bull trout from both core areas to be present in the action area. Bull trout from the Dungeness core area are fluvial and anadromous. With the removal of the two dams on the Elwha River, bull trout have been observed moving freely up and downstream in the lower river, indicating that the populations in this core area may soon become anadromous again. All life history forms are believed to exist in the Elwha Core Area. Bull trout have been documented in some of the nearby tributaries, including Ennis, Bell, Siebert, and Morse Creeks but regular surveys are not performed and current abundance is unknown. Bull trout presence in the action area is expected to be very low between October and February, when most mature bull trout have returned to their natal waters to spawn and overwinter and prey abundance is lower. However, bull trout may be found foraging and migrating in the action area at any time of year, particularly non-spawning subadults.

Bull trout populations in the Elwha and Dungeness River core areas have been impacted by degraded habitat and reduced prey abundance as direct result of rising human populations and development along marine shorelines and rivers. While in the marine environment, bull trout foraging and migration are likely impacted by the bank armoring that degrades shoreline habitat. Shoreline armoring reduces spawning habitat for marine forage fish, which impacts prey abundance for bull trout. Armoring the shorelines can increase the energetic demand of bull trout during migration and reduce their source of forage base, which can affect individual fitness.

**Conservation Role of the Action Area for Bull Trout**

The conservation role of the action area is important for bull trout from both the Elwha and Dungeness River core areas. Bull trout from the Elwha and Dungeness Rivers migrate into saltwater to forage and travel along the coast into coastal tributaries, bays, or estuaries to reach additional foraging and overwintering sites. Many prey species for bull trout are concentrated in the nearshore environment. Bull trout have been detected throughout these two rivers, at their mouths, and in tributaries around Port Angeles Harbor. The action area provides opportunity for foraging and migrating in the marine environment. With the removal of the two dams on the Elwha, we expect bull trout may be present in the action area any time of year.

Threats exist in the action area that needs to be addressed to assist in establishing self-sustaining populations of bull trout and aid in the recovery of the species. The marine foraging habitats present in Port Angeles Harbor are impacted by residential and commercial development in shoreline areas. This type of development degrades shoreline conditions, intertidal habitat, and water quality. Many tankers and large shipping vessels anchor in Port Angeles Harbor while waiting for pilots to escort them into Puget Sound. The high vessel traffic in the action area increases the risk and potential for spills and impacts to water quality.

**Status of Bull Trout Critical Habitat in the Action Area**

The nearshore marine environment in Port Angeles Harbor was designated as bull trout critical habitat on October 18, 2010 (75 FR 63898). These nearshore areas are used by anadromous bull trout seasonally for foraging and migration.

The current conditions of PCE's that are present in the action areas are described below.

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

The action area likely is used by bull trout from the Elwha and Dungeness River core areas. In the action area, the migratory corridor habitat is degraded from the loss of shoreline complexity that has occurred as a result of bank hardening and development, especially bulkheads and over-water structures, such as marinas and piers, ramps, and docks along the Port Angeles waterfront and throughout the harbor. Although the migratory corridor has been degraded by these impediments, and is functionally impaired, bull trout are still able to move between spawning, rearing, overwintering, and freshwater and marine foraging habitats.

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

Prey abundance in the action area has been impacted by development along the shoreline, which has degraded habitat for forage fish such as Pacific herring, sand lance, surf smelt, and juvenile salmonids. Bank armoring and other land use practices have decreased the availability of prey by reducing the amount of mature vegetation along the shorelines, large woody debris, and preventing bluff erosion with interrupts beach-forming processes and reduces spawning habitat for marine forage fish. Bank armoring in the action area has also diminished nearshore transport of materials, caused sediment aggradation, and simplified intertidal habitats with bulkheads. As the conditions become more degraded by development, the habitat is less able to sustain these prey resources. The action area is likely functioning with limited and/or reduced capacity to provide an abundant food base as a direct result of shoreline armoring and development.

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

Habitat complexity in the action area has been reduced by bank armoring, bulkheads, development, and overwater structures, which have degraded and removed components that create, maintain, and/or provide complexity. Recruitment of large woody debris, sediment inputs, and established riparian vegetation is reduced or eliminated by hardening banks and permanent structures along the waterfront and all around the harbor. The complexity of the shoreline environment and the processes that establish and maintain them and the functions they provide are impaired.

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

Water quality in the marine environment of Port Angeles Harbor is currently impaired. The harbor is on the Washington Department of Ecology's 303(d) of impaired waterways for 31 different pollutants/contaminants (WDOE, in litt. 2015). Long-term water quality monitoring has shown that parameters have been exceeded in Port Angeles Harbor for all 31 of these contaminants (WDOE, in litt. 2015).

*Summary of Critical Habitat Condition*

Factors responsible for the condition of bull trout critical habitat in the nearshore marine environment include shoreline development, impairments to water quality from surface-water runoff and pollutant loading, and bank armoring to protect infrastructure. Many of the Port Angeles shorelines and other parts of the action area have been altered by some form of development, resulting in the widespread loss of complex habitat-forming processes that form the shoreline habitats needed by bull trout and their prey resources. Rural and urban development increases pollutants introduced into the aquatic system. A number of negative impacts to the aquatic and riparian habitat have occurred in the action area due to past human activities, and the effects of these past activities are expected to continue into the future.

**Conservation Role of Bull Trout Critical Habitat in the Action Area**

The conservation role of critical habitat for bull trout in the action area is primarily to support migrating and foraging bull trout while they are in the marine environment. The condition of water quality and the habitat in the action area influences several life history stages of bull trout, including adult and subadult bull trout. The Service considers all marine and estuarine waters and independent tributaries necessary for foraging, migration, and overwintering to be necessary habitat for bull trout in the Strait of Juan de Fuca. The marine foraging, migration, and associated overwintering habitats are important for bull trout originating from the Elwha and Dungeness River core areas for maintaining diversity of life history forms and for providing access to habitat that provides productive sources of prey.

Threats that need to be addressed in the action to ensure recovery include the impacts from shoreline development to critical habitat that reduce prey resources and habitat complexity. The intended recovery function of critical habitat is to support the core areas and ensure that the habitat requirements of bull trout are met, now and in the future. The migration habitat, prey base, habitat complexity, and water quality in Port Angeles Harbor have been degraded by development, a rising human population, industry infrastructure, and contaminants.

**Climate Change**

Our analyses under the ESA include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). 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).

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

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

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

Bull Trout

Recent observations and modeling for Pacific Northwest aquatic habitats suggest that bull trout and other salmonid populations will be negatively affected by ongoing and future climate change. Rieman and McIntyre (1993, p. 8) listed several studies which predicted substantial declines of salmonid stocks in some regions related to long-term climate change. More recently, Battin et al. (2007) modeled impacts to salmon in the Snohomish River Basin related to predictions of climate change. They suggest that long-term climate impacts on hydrology would be greatest in the highest elevation basins, although site specific landscape characteristics would determine the magnitude and timing of effects. Streams which acquire much of their flows from snowmelt and rain-on-snow events may be particularly vulnerable to the effects of climate change (Battin et al. 2007, p. 6724). In the Pacific Northwest region, warming air temperatures are predicted to result in receding glaciers, which in time would be expected to seasonally impact turbidity levels, timing and volume of flows, stream temperatures, and species responses to shifting seasonal patterns.

Battin et al. (2007, p. 6720) suggest that salmonid populations in streams affected by climate change may have better spawning success rates for individuals that spawn in lower-elevation sites, especially where restoration efforts result in improved habitat. Higher elevation spawners (like bull trout) would be more vulnerable to the impacts of increased peak flows on egg survival. They further note that juvenile salmonids spending less time in freshwater streams before out-migrating to the ocean would be less impacted by the higher temperatures and low flows than juveniles that rear longer in the streams. Bull trout generally spawn in cold headwater streams, and juveniles may spend one to three years rearing in cold streams before moving downstream to large river reaches or estuarine/marine habitats. Therefore, bull trout would be less likely than other salmonids to be able to adjust their spawning habitat needs related to water temperature. Connectivity between lower and upper reaches of a river system and marine waters may become even more critical for the growth and survival of fluvial and anadromous individuals that access the action area for foraging, migrating, and overwintering purposes.

Changes in climate have been identified that are occurring now or will occur over the next 50 to 100 years (Glick et al. 2007, p. iii; Mote et al. 2005, p. 4). The predicted changing precipitation patterns are expected to result in more frequent severe weather events and warmer temperatures (Mote et al. 2005, p. 13). Glaciers in the Cascades and Olympics Mountains have been retreating during the past 50 to 150 years in response to local climate warming. Regional warming can result in reduced winter snowpack, earlier occurrence of peak runoff, and reduced summer flows.

If the current climate change models and predictions for Pacific Northwest aquatic habitats are relatively accurate, bull trout from the three core areas, the Lower Skagit, Stillaguamish, and the Snohomish/Skykomish River that are expected to be in the Crescent Harbor portion of the Inland Water Subunit, are likely to be impacted through at least one or more of the following pathways:

- Changes in distribution of bull trout within the core area, such as reduced spawning habitat, and/or seasonal thermal blockage in the migratory corridors associated with increased stream temperatures.
- Disturbance or displacement of eggs, alevins, juveniles, and adults of resident and/or migratory adults during winter flooding events.
- Short-term or long-term changes in habitat and prey species due to stochastic events during winter floods.
- Changes in flow/out-migration timing in the spring for bull trout and their prey species.
- Increased migration stressors from lower stream flows and high stream temperatures during spawning migrations.

<u>Marbled Murrelet</u>

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 (Salathe Jr 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 (Littel 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 (Littel 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.

**Previous Consulted on Projects within the Action Area**

Since 2007, the Service has consulted on 25 projects within the action area. Twenty-four of the projects were informal consultations with minor temporary impacts to bull trout or bull trout critical habitat. Restoration projects included removal of bulkheads and other bank stabilization structures to increase inter-tidal beach habitat and provide natural banks. Other projects included the installation or maintenance of piles, piers, and bank stabilization structures to protect existing infrastructure. Most of these informal projects involved temporary, short duration increases in turbidity, suspended sediments, and contaminants. Some of the work occurs in the dry that minimizes impacts to marbled murrelets and bull trout.

One formal consultation has been conducted in the action area. A programmatic consultation involving pile replacement and maintenance of other structural components at eight shoreline facilities along the Port Angeles waterfront (duration of the programmatic is 2015 through 2025). Effects to marbled murrelets and bull trout included injury and mortality due to exposure to elevated SPLs from impact pile driving. The Service estimated that up to two foraging groups (pair or 3 birds) of marbled murrelets would be harmed.

## EFFECTS OF THE ACTION

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.

*Interdependent and Interrelated Actions*

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdepended actions are those that have no independent utility apart from the action under consideration" (50 CFR 402.02).

Icicle Acquisition Subsidiary, LLC. (American Gold Seafoods) owns and operates a commercial net pen fishery for Atlantic salmon (*Salmo salar*) just south and southwest of the project area. Icicle Acquisition Subsidiary, LLC. has applied for permits to relocate the net pens from their current location in the Port Angeles Harbor out into the Strait of Juan de Fuca (east of Ediz Hook). Additional net pens to enlarge the facility would also be added. Because the Service will be consulting on the net pen project with the U.S. Army Corps of Engineers as a separate action, effects to listed species associated with the relocation of the net pens are not addressed in this consultation.

**Insignificant and Discountable Effects (Marbled Murrelets and Bull Trout)**

*Bank Hardening (Marbled Murrelets and Bull Trout)*

The approach trestle to the new pier will be attached on shore to an abutment that will be constructed 1.7 ft above the mean higher high water (MHHW) line. The abutment will be made of three 18-inch diameter piles and 110 linear feet of sheet pile. All piles will be installed with a vibratory pile driver. Installation of the piles using a vibratory pile driver will result in increased noise and disturbance that may result in behavioral changes, such as avoidance of the area, to marbled murrelet and bull trout in the area. However, the increased noise and disturbance will be temporary and will not result in injury or measurable effects to the normal behavior of either species.

The abutment will be constructed 1.7 ft above the MHHW line which will not result in loss of any forage fish spawning habitat or loss of intertidal habitat. The abutment will result in the loss of a minimal amount of upland sediment during times when waves would inundate the upper beach, above the MHHW line. The Service expects the effects of the installation of the abutment above the existing bank armoring to be insignificant to marbled murrelets and bull trout.

*Turbidity/Suspended Sediments (Marbled Murrelet and Bull Trout)*

Turbidity and suspended solids will be elevated during the installation of piles. The turbidity created by these activities is expected to be temporary, intermittent, and extend approximately 150 ft from each pile while it is being installed before levels disperse to background levels. We expect tidal and wind currents will aid in the dispersal of the turbidity and suspended sediments, minimizing exposure of marbled murrelets and bull trout to elevated turbidity and suspended sediment concentrations. We do not expect marbled murrelets or bull trout to be exposed to turbidity at concentrations or durations that would measurably affect their normal behavior. Therefore, effects to bull trout and marbled murrelets due to short-term exposure to elevated levels of turbidity are considered insignificant.

*Stormwater*

The project involves the construction of a pier and floats that will result in an increase of 25,456 square feet of solid overwater structure (not grated). The Navy will treat all stormwater runoff from the pier, trestles and gangways. Stormwater treatment will occur by a system that uses a filtration media to trap particulates and absorb contaminants. While the pier is considered a pollution-generating impervious surface, the use of the pier will be limited to loading, unloading, and maintaining the TPS vessels.

Upland/onshore construction that will result in additional permanent impervious surfaces include an 8,200 square foot sleeping/hotel building, a new parking lot (40 ft by 170 ft), a 10 ft by 20 ft munitions storage armory, an above-ground fuel storage tank that will be sitting on a concrete pad and a new parking area for the fuel truck. A total of 10,700 square feet of impervious surface will be created in the uplands and approximately 5,200 square feet of existing pavement will be removed, for a net increase of 5,500 square feet of new impervious surfaces in the uplands.

The primary pollutants of concern in stormwater from road surfaces are total suspended solids, total zinc, dissolved zinc, total copper, and dissolved copper. Stormwater runoff from all impervious surfaces will be collected and treated using a combination of oil/water separators, filter cartridges and a stormwater detention/infiltration pond (which will be constructed just west of the new pier near the parking area) prior to being discharged.

The effects of exposure to contaminant in stormwater runoff range from behavioral changes to bull trout at small concentrations, to sublethal and lethal effects at high concentrations. Behavioral changes result from bull trout avoiding or abandoning preferred foraging or migrating habitat. The Service expects that very low levels of contaminants will enter Port Angeles Harbor due to the operation of the pier. We do not anticipate exposure to chemicals in stormwater runoff to occur at a frequency, duration or concentrations to result in a significant impairment of normal behaviors of marbled murrelets or bull trout. Thus, effects to bull trout and marbled murrelets due to chemical contamination or impacts to water quality from stormwater runoff are considered insignificant.

**Adverse Effects to Marbled Murrelets and Bull Trout**

*Exposure to Elevated Sound*

**Sound Metrics and Key Terms**

- Amplitude: measurement of the acoustic energy of sound vibrations. Sound amplitude is measured on a logarithmic scale in units called decibels.

- Critical Ratio (CR): the difference, in dB, between a hearing threshold and a masking noise.

- Decibel (dB): a numerical expression of the relative loudness of a sound.

- Frequency: the rate of oscillation or vibration of sound measured in cycles per second, or hertz (Hz). Ultrasonic frequencies are those that are too high to be heard by humans (greater than 20,000 Hz); and infrasonic sounds are too low to be heard (less than 20 Hz).

- Masking: interference with the detection of one sound by another (Dooling and Therrien 2012).

- Masked threshold (MT): the quietest sound level that is detectable when combined with a specific masking noise.

- Practical Spreading Model: used by the Service to estimate the distances at which injury and behavioral disruption are expected. The Model assumes that SPLs decrease at a rate of 4.5 dB per doubling of distance in the underwater environment. This Opinion assumes transmission loss occurs from practical spreading of sound as described by Davidson (2004) and Thomsen et al. (2006) [TL = 15*Log(R)] where R is the range or distance the sound extends from the source.

- Received level (RL): the sound level at the receiver of interest (in this case a murrelet).

- Reference pressure: the pressure value used in calculating SPLs in decibels (dB). This document refers to both underwater and in-air SPLs. Underwater sounds are referenced to 1μPa and in-air sounds are referenced to 20μPa.
    - The reference pressure for in-air sound of 20 μPa is based on a human hearing threshold. The difference in the underwater and in-air reference values account for the difference in the density of the media (water vs. air).

- Sound: vibrations in air or water that stimulate the auditory nerves and produce the sensation of hearing. The perception of a sound depends on two physical characteristics, amplitude and frequency, both of which can be measured.

- Sound pressure levels (SPL): sound pressure that is expressed in dB. In this document, underwater SPLs are referred to in units of dB re: 1 μPa and are denoted as dB.
    - Peak pressure (peak): the highest level or amplitude or greatest absolute sound pressure level during the time of observation. Sound pressure levels expressed as peak are used in discussing injury or mortality to aquatic species.
    - Sound exposure level (SEL): a metric that incorporates both sound pressure level and duration. SEL is calculated as 10 times the logarithm of the integral, with respect to duration, of the mean-square sound pressure, referenced to $\mu Pa^2$-sec. Using this metric, 0-dB SEL corresponds to a continuous sound whose root mean square sound pressure equals the reference pressure of 1 μPa at a duration of 1 second (Morfey 2001, p. 347).
    - Root Mean Squared (RMS): is root square of the energy divided by the duration. Sound pressure levels expressed as rms are commonly used in discussing behavioral effects. Behavioral effects often result from auditory cues and may be better expressed through averaged units than by peak pressures.

- Spectrum level (SL): the amount of sound energy at a particular frequency, in dB.

- Threshold shift (TS): temporary or permanent changes in auditory sensitivity as a result of exposure to noise (Saunders and Dooling 1974, p. 1962).

- Transmission loss (TL): the loss of sound energy as sound passes through a medium such as water. Several factors are involved in TL including the spreading of the sound over a wider area (spreading loss), losses to friction (absorption), scattering and reflections from objects in the sound's path, and interference with one or more reflections of the sound off of surfaces (in the case of underwater sound, these surfaces are the substrate and air-water interface. Transmission loss in air occurs from contact with landforms, trees or buildings).

The proposed project will generate both airborne and underwater sound primarily from impact and vibratory pile driving. The installation of steel piles using an impact hammer pile driver is expected to produce the highest levels of sound of all construction-related activities. Although vibratory pile driving also produces elevated levels of sound, the waveform and rise times of the sound are different than impact pile driving and are not currently associated with the same risk of physical injury as impact pile driving steel piles.

Vibratory installation of hollow steel piles produces sounds above 150 $dB_{RMS}$ and even up to 180 dB peak; however, the sounds from vibratory installation differ from impact installation in intensity, frequency, and impulse energy (total energy content of the pressure wave) (Teachout, in litt. 2010, p. 15). Most of the sound generated by impact hammer pile driving hollow steel piles is concentrated between 100 and 800 Hz, the frequencies thought to be most harmful to aquatic animals, while the sound energy from the vibratory pile driving hollow steel piles is concentrated around 20 to 30 Hz (Teachout, in litt. 2010, p. 15). Additionally, during the strike from an impact hammer, the sound pressure rises much more rapidly than during the use of a vibratory hammer (Carlson et al. 2001, p. 23; Nedwell and Edwards 2002, p. 10). Depending on the location of the vibratory installation, SPLs may not exceed ambient sound levels. Vibratory installation of steel piles in a river in California resulted in SPLs that were not measurable above the background noise created by the current (Reyff 2006, p.2).

The sounds created by vibratory pile driving are different from impact installation and the responses of marbled murrelets and bull trout are also expected to differ. We expect marbled murrelets and bull trout 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 how the sound from vibratory pile driving behaves is different than sound from impact pile driving, and that the sound will be intermittent and non-impulsive, we expect marbled murrelets and bull trout will not be injured and will be able to continue foraging in the action area. Because effects to marbled murrelets and bull trout from vibratory pile installation are considered to be insignificant, the remainder of the Opinion will only focus on the effects to these species associated with impact pile driving.

**Marbled Murrelets**

In-Water Sound

The action area provides suitable marine habitat for the marbled murrelet and is known to support moderate concentrations during both the summer and winter months. Marbled murrelets forage on a variety of small marine fish that use the nearshore intertidal environment of Port Angeles Harbor. This projects' in-water construction will start in mid-July each year, at the end of the marbled murrelet nesting season. The work season will end by mid-February. Between mid-July and mid-October we expect marbled murrelets will be foraging for themselves and/or their chicks, or may be foraging with their newly fledged young. Marbled murrelets may also use Port Angeles Harbor, and the Action Area for resting, loafing, and other activities. In-water construction will occur over two years. Marbled murrelets are frequently seen just offshore in Port Angeles Harbor and there are documented observations in forested areas within approximately 2 miles (southwest) of the project. Based upon location and documented observations , we expect that marbled murrelets use the nearshore waters of Port Angeles Harbor regularly and are likely to be present during construction and the long-term operation of the replaced structures.

Effects to marbled murrelets from exposure to elevated underwater sound pressures 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 platyrynchos*) (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). This hair cell loss can be temporary or permanent, depending on exposure level. The Service expects that the onset of injury (hair cell loss) would occur at 202 dB cumulative SEL. However, temporary 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 comprised of researchers, biologists, and acousticians, whom recommended that the onset of injury may occur with exposure to a cumulative SEL equal to or exceeding cumulative 202 dB (re: 1 μPa). Furthermore, they suggested that other physical injuries (i.e., barotrauma), could be expected when sound exposure levels meet or exceed a cumulative SEL of 208 dB (SAIC 2011). As used here, cumulative SEL is a metric for the total energy content of an impulsive sound event, or events. Injuries associated with exposure to sound at or above these thresholds results in barotrauma, which can include death, and/or hemorrhaging and rupture of internal organs. SEL is recommended as a way to better account for both the negative and positive pressure excursions (Hastings and Popper 2005, p. 11).

The expert panel (SAIC 2011) 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) 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.

Beginning with the values of the expert panel (SAIC 2011) for assessing the risk of direct injury, including hair cell loss, we consider 202 dB SEL (cumulative) to be the onset of hair cell loss and injury to marbled murrelets. The SEL that will result from impact pile driving for the proposed projects, accumulated over all pile strikes, will exceed 202 dB (re: 1 μPa2-sec). The number of pile strikes is estimated per continuous work period (per day). 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 temporary threshold shift hearing impacts. Therefore, 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.

To calculate estimated areas of injury from impact pile driving we determined the distance at which transmission loss (TL) attenuates sound to levels below specified thresholds. We use practical spreading (defined above in the section called Key Terms) to estimate the aquatic area where effects from underwater sound are expected. This analysis assumes that sound pressure decreases at a rate of 4.5 dB per doubling of distance (see Key Terms for more details). Monitoring data from pile driving projects indicate that the actual spreading loss is intermediate between cylindrical and spherical spreading (Reyff 2003, pp. 9-10; Thomsen et al. 2006, p.15).

The Navy provided sound source levels and pile strike information for conducting the sound analysis. Sound levels were provided for 24 and 30-inch diameter steel piles as those levels were higher than those for 36-inch diameter steel piles based off of a review of pile driving studies and literature (Navy 2014). Sound levels for the 24 and 30-inch diameter steel piles are provided in Table 1.

Table 1. Unattenuated impact pile driving sound source levels for 24 and 30-inch diameter steel piles.

| Pile Size | Average RMS dB re 1 µPa | Average Peak dB re 1 µPa | Average SEL |
|---|---|---|---|
| 24 | 193 | 210 | 181 |
| 30 | 195 | 216 | 186 |

For pile installation, a vibratory hammer will be used first. If the vibratory method is not sufficient to complete the installation, an impact hammer will be used. If full impact pile driving would be needed to install piles, up to 7,000 strikes per day could be required and/or 200 strikes per pile for proofing. Therefore, to conduct a conservative analysis, we used sound levels for a 30-inch diameter steel pile, with 7,000 strikes per day, and an 8 dB reduction in sound level with use of a bubble curtain that would be monitored to verify sound levels. Short-term adverse effects (temporary hearing loss or impairment, injury or mortality) to marbled murrelets would occur from elevated underwater SPLs during impact pile driving within a zone extending 92 meters from pile installations (Figure 6).

Proofing at the end of installation would be conducted with an impact hammer for one of every three trestle piles and one of every four pier piles. The Navy estimated that 200 strikes per pile would be needed for proofing. These 200 strikes are included in the up to 7,000 strikes per day worst-case estimate above.

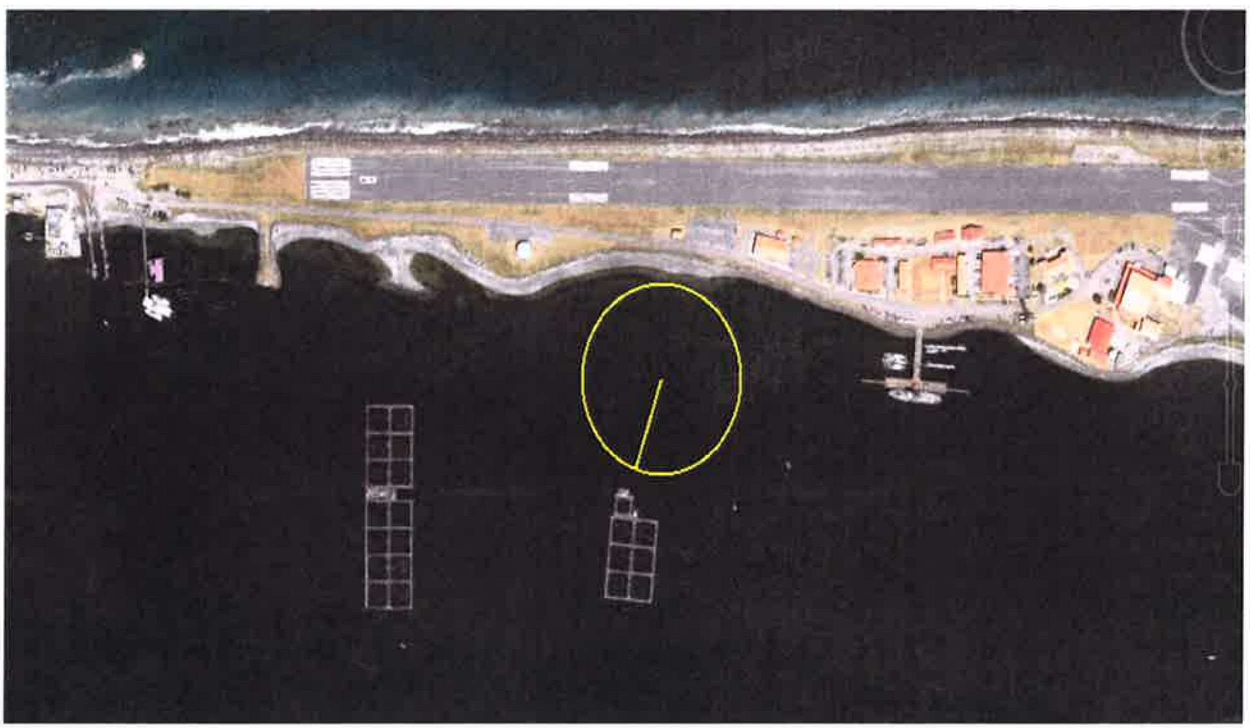

Figure 6. Representative area (93 m, approximately 0.03 km$^2$) of potential exposure to injurious levels of underwater sound for marbled murrelets for impact pile driving at approximate location of a pile installed at the outer edge of the project.

The zone of potential injury for marbled murrelets associated with exposure to elevated underwater SPLs extends approximately 92 meters from the location of impact pile driving. The cumulative probability of encountering a marbled murrelet during the impact hammer pile driving is above what the Service considers a discountable level ($p < 0.1$), and exposure to these stressors resulting in potential injury and/or harassment are reasonably certain to occur (probability of exposure exceeds 50 percent). If marbled murrelets are present and exposed within the zone of injury (within 92 meters of pile driving) 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.

On-the-water or land-based monitoring within the area of potential injury (0 to 92 m) and stationary surveys will be conducted within the masking zone (between 92 m and 168 m from each impact-driven steel pile) according to a Service-approved monitoring protocol; pile driving will be stopped if individuals are observed within 168 meters of impact pile driving activities and will not resume until the birds have voluntarily left the area. When steel piles smaller than 36-inches in diameter are impact driven, the area where masking could occur extends 42 m from the location where the pile is being installed. However, this area will be monitored by boats during surveys intended to prevent injury and mortality associated with underwater sound (underwater sound that exceeds the onset of injury extends 92 m from impact pile driving).

Monitoring for individuals will reduce, but not eliminate, the extent of adverse effects to marbled murrelets associated with the impact pile driving. The protocol assumes that 78 percent of marbled murrelets would be detected during on-the-water monitoring and 22 percent would be missed. The exposure calculator predicts that there is a 94 percent probability that up to 1 group of marbled murrelets would be exposed to elevated underwater SPLs that could cause injury or a significant impairment of normal behavior during project construction. Based on documented presence, abundance levels, and likelihood that some birds will be missed during surveys, it is reasonable to assume that that one group of marbled murrelets will be exposed to underwater SPLs that could result in injury or mortality.

*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 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 meters (SAIC 2012, p. 16). Therefore, foraging pairs of marbled murrelets need to receive these vocalizations at a level where they can recognize the calls. If significant threshold shifts in their hearing occurs from exposure to in-air sound it could limit their recognition of these communication signals.

We consider effective communication between foraging partners to be the critical hearing demand for marbled murrelets at sea. Signal detection and recognition is significantly affected by the properties of background 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.

We expect masking would occur when impact pile driving sound impinges on vocalizations within the 30 meter maximum communication distance for foraging murrelets (Teachout, in litt. 2013, p. 10) for durations that would preclude communication enough to reduce their foraging efficiently. There is a potential that one foraging groups will be present and exposed to in-air sound while foraging and it is reasonable to assume that this will result in masking of their communication when impact pile driving is conducted for prolonged periods of time (e.g. full installation of piles using impact method). This foraging group 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.

The proposed project assumes a maximum of 7,000 strikes of impact pile driving per day for up to 75 days. The Service expects that impact pile driving of up to 36-inch diameter steel piles will significantly disrupt communication between foraging subadult and adult marbled murrelets within 168 m of pile driving activities.

**Adverse Effects to Bull Trout**

Port Angeles Harbor provides essential foraging and migrating habitat for anadromous adult and subadult bull trout. These marine areas provide habitats that are crucial for maintaining diversity of bull trout life history and access to productive foraging areas. Port Angeles Harbor is located between and in close proximity to the Dungeness and Elwha River core areas. Bull trout migrate long distances and may be found foraging and migrating in the action area at any time of year. Bull trout may be attracted to the prey fish found in the intertidal environment along the shorelines within and near Port Angeles Harbor. However, bull trout presence in the action area is expected to be lowest during the project work, between July 16 and February 15, when most mature bull trout have returned to their natal waters to spawn and overwinter.

*Exposure to Elevated In-Water Sound*

Bull trout within 736 meters of impact pile driving will be exposed to underwater SPLs that will exceed the onset of injury thresholds established by the Fish Hydroacoustic Working Group (187 dB SEL for fish greater than two grams in mass). Potential behavioral impacts could occur within 1.8 miles of the pile driving; this is the distance that underwater sound will travel underwater until it attenuates below 150 $dB_{RMS}$, where it is no longer expected to impact bull trout behavior. The work would occur during the approved in-water work window for bull trout, from July 16 through February 15. However, working during the approved work window does not eliminate the possibility that adult and/or subadult bull trout would be present.

Based on the assumptions described above, zones of potential injury corresponding to a cumulative SEL of 187 dB (injury threshold for fish larger than 2 grams) would extend approximately 736 meters from construction activities (Figure 7). High underwater SPLs are known to injure and/or kill fish by causing barotraumas (pathologies associated with very high sound levels, including hemorrhage and rupture of internal organs), swim bladder rupture, hemorrhaged eyes, temporary stunning, and alterations in behavior (Turnpenny et al. 1994). Death can be instantaneous, occur within minutes after exposure, or occur several days later. If present and exposed, the magnitude of SPLs and duration of impact pile driving could result in death, injury, or significant disruption to their normal behavior. Pile driving will result in death, injury, and/or significant disruption in normal behavior to all sub-adult and adult bull trout within 736 meters of the project area.

Figure 7. Area of potential injury for bull trout during impact pile driving (approximately 209 acres, within 736 meters of pile driving).

*Long-Term Effects to Habitats and Prey Resources (Marbled Murrelet and Bull Trout)*

The proposed in-water structures, including the trestle, fixed pier, mooring dolphins, and floats, are not within or near documented marine forage fish spawning locations. Most of the nearshore areas along the waterfront in Port Angeles have been altered and degraded by shoreline development and suitable spawning areas for marine forage fish are located at dispersed locations within the action area (Figure 5). The proposed in-water structures will be constructed through eelgrass which provides valuable refuge, foraging, and spawning habitat for many marine species including juvenile salmonids and forage fish (Figure 4) (Plummer et al. 2012, p. 1).

The proposed project will result in temporary increased SPLs, permanent loss of eelgrass and a permanent increase in overwater structures that may impact forage fish and their habitat. The proposed project will result in the installation of 144 permanent piles and 80 temporary or indicator piles ranging in size from 18 to 36 inches in diameter. The pier and floats will result in an increase of 25,456 square feet (0.6 acre) of overwater structures. The increase in shading caused by the new overwater structures is expected to be offset by the proposed mitigation, which will result in the removal of 35, 780 square feet (0.8 acre) of fill and restoration of shallow water habitat in the nearshore area.

Impact pile driving activities results in a calculated distance to the fish injury threshold for fish greater than two grams of 736 m. The Service was unable to find any information on forage fish abundance estimates in Port Angeles Harbor. The Service expects that an unknown number of Pacific sand lance and surf smelt will be injured or killed due to impact pile driving.

The in-water structure has been designed to minimize impacts to eelgrass with the piers and floats being constructed in deeper water, out of the eelgrass beds. The proposed approach trestle will be constructed through the eelgrass beds with approximately 745 square feet of eelgrass being directly affected from the placement of piles, and approximately 4,260 square feet will be impacted due to shading by the approach trestle. The mooring of boats at the pier will occur in deeper water and should not result in the shading of eelgrass.

As stated in the project description, the Navy is in discussions with the Port Gamble S'Klallam, Jamestown S'Klallam, and Lower Elwha Klallam Tribes to examine the feasibility of salvaging eelgrass that may be lost due to the project and transplanting them to shallow subtidal sites within the action area. While eelgrass salvaging and transplanting has not been found to be totally successful, research is ongoing and new methods are being tried to increase eelgrass survivability (Hudson 2012). In addition, the Navy will be conducting two mitigation projects that will restore intertidal habitats that will provide additional substrate for eelgrass and habitat for bull trout prey species.

We expect that the long-term effects of the new pier will result in significant and measureable effects to the eelgrass bed and therefore, bull trout prey resources associated with eelgrass. However, we are unable to quantify the potential impact to bull trout prey resource productivity, abundance, or availability within Port Angeles harbor. We expect that both marbled murrelets and bull trout will continue to access and successfully forage and migrate within the action area.

Operation of the new facility will not result in increased traffic associated with vessels escorting Navy submarines to and from Bangor or training areas in Puget Sound. The vessels (primarily USCG ships) currently anchor elsewhere in Port Angeles harbor (e.g. docks along the waterfront, in the harbor, or at the existing AIRSTA/SFO pier on Ediz Hook) during crew layover times. The primary purpose of the project is to provide a consolidated location for the escort vessels to dock and crews to spend the night.

**Summary of Effects by Stressors**

Impact pile driving during construction will result in injury, mortality, and/or behavioral changes of marbled murrelets, bull trout, and forage fish associated with exposure to elevated SPLs. Marbled murrelets within 92 m and bull trout and forage fish within 736 m will be exposed to injurious levels of underwater SPLs. The Service expects that one group of marbled murrelets, all bull trout, and an unknown number of forage fish within the area of effect (92 m for marbled murrelets and 736 m for fish) will be exposed to underwater SPLs that may result in injury, death, and/or significant disruption of their normal behaviors.

Prolonged exposure to elevated levels of in-air sound is expected to result in masking of marbled murrelet communication up to 168 m from impact pile driving activities. We expect that some marbled murrelets may flush by diving, flying, or avoiding the area as an initial response to the increased sound, which could result in lost foraging opportunities and increased energetics.

Long-term effects to habitat and prey resources are expected to be measurable because the approach trestle will be constructed over eelgrass and will diminish current habitat function in the action area. However, the Service is unable to measurably quantify the reduction in prey resource productivity, abundance, or availability. We expect that both marbled murrelets and bull trout will continue to access and successfully forage and migrate within the action area upon completion of the project. The action will not measurably affect the normal behaviors of marbled murrelets or bull trout within the action area over the long-term (i.e., ability to successfully feed, move, and/or shelter).

**Bull Trout Critical Habitat**

The proposed project is anticipated to result in both short- and long-term effects to designated critical habitat. The proposed action will have the following effects to the PCEs in the action area:

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

The action area is used by anadromous bull trout for migration, foraging, and overwintering. Impact pile driving may temporarily preclude migration through the action area; however, the elevated underwater sound will be intermittent and bull trout will still be able to migrate through the action area (during the daytime between pile installations and at night when pile driving is not occurring). Other construction elements that will result in short-term localized impacts to the migratory corridor include increases in turbidity and suspended solids. Increased turbidity and elevated levels of suspended solids may deter bull trout from migrating through the area, and may cause bull trout to be displaced or temporarily avoid the site when construction activities are occurring.

The construction and use of the pier and floats will result in a temporary barrier to bull trout migration as salmonids have been observed avoiding piers (Toft et al. 2004; Anchor QEA 2012). The proposed project will result in an increase of 25,456 square feet (0.6 acre) of overwater structures, with the vast majority at water depths exceeding – 50 ft MLLW. This does not include the larger vessels and support boats that will be moored at the pier and floats. These vessels will result in increased shading at the project site. All of these vessels are currently moored at other locations within the action area.

We do not anticipate that impacts to the migratory corridor from these stressors will measurably affect this PCE because they will not prevent bull trout from moving through the action area during or after construction. Based on bull trout use of the nearshore areas, critical habitat, including the migratory corridor, extends to the edge of the photic zone (shore to -33 ft MLLW).

Most of the permanent overwater structures are in deeper water and will not impact this PCE. Because the project will not preclude bull trout from moving through the area and will not impair the function of the migratory corridor over the long-term, effects to this PCE are considered insignificant.

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

Impacts from construction are expected to result in short- and long-term effects to the food base of bull trout. Elevated underwater SPLs during impact pile driving, elevated levels of turbidity and suspended sediments, and permanent loss or impacts to eelgrass will result in prey items such as aquatic macroinvertebrates and forage fish being injured, killed, or temporarily abandoning the area or habitat during construction and operation of the pier and floats. There are no documented forage fish spawning areas in the immediate vicinity of the project area. The documented forage fish spawning locations area scattered throughout the action area. However, we expect some forage fish to be present and injured or killed during pile driving. The Service expects a loss of approximately 745 square feet of eelgrass from placement of piles, and approximately 4,260 square feet will be impacted due to shading from the approach trestle. The loss of eelgrass will result in a slight reduction of nearshore habitat that may be used by forage fish. The north-south alignment of the trestle will allow some light to penetrate beneath the edges of the structure when the angle of the sun is lower (morning and afternoon). Because the project will not result in measurable effects to forage fish abundance and distribution, effects to this PCE are considered insignificant.

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

The project involves the installation of 144 piles and 25,456 square feet of permanent new overwater structure. The retaining wall, pilings for the approach trestle, pier and floats will interrupt or restrict intertidal longshore sediment transport and other nearshore functions and process. The sheet pile retaining wall and pilings will also interrupt the transport of large wood along the nearshore and overwater structures will shade eelgrass and other aquatic vegetation in the shallow nearshore and intertidal zone. Although the compensatory mitigation (removing 37,780 square feet of fill along the shoreline) will result in the restoration of approximately 0.8 acre of intertidal and shallow-water habitat to the west of the new pier, it does not fully compensate for impacts to eelgrass and nearshore drift associated with the new trestle and pilings in the nearshore area.

The proposed action will measurably diminish habitat complexity and impact the natural processes that contribute to the formation and maintenance of complex habitat along the shoreline of Ediz Hook. Although the action will have adverse effects, it will not prevent or preclude the PCE from functioning or meeting the intended recovery objectives in the action area.

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

The proposed project will result in the short-term localized increase in turbidity and suspended sediment during installation of the 144 piles. Over the long-term, there is a potential for stormwater contaminants to enter Port Angeles Harbor. Vessel use concentrated at the new pier may also contribute to periodic impacts to water quality. Because construction-related impacts to water quality will be short-term and will not impair the function of this PCE and stormwater runoff from impervious surfaces will be adequately treated, the Service does not expect the action to result in measurable effects to this PCE over the long-term.

## CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action areas considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. Current and future stressors are expected to adversely affect bull trout, including urban development and climate change, which are likely to affect conditions in the action area.

In general, cumulative effects from activities and land uses within and affecting the action area range from rural and agricultural activities to urban development along the shorelines. Most permitted activities in the action area that involve in-water work would have a federal nexus and would be reviewed under separate section 7 consultations. However, a number of projects that are under the scope of local jurisdictions or are undertaken without a permit are expected to occur in the foreseeable future. These include increased development, transportation projects, and other projects.

Urban development in the action area will likely result in increased stormwater and wastewater discharges associated with runoff from impervious surfaces in the uplands. Marbled murrelets, bull trout, and their prey species are likely to be negatively affected as a result of degraded water quality from these discharges. The severity of impacts will depend on the concentration discharged and the level of exposure that marbled murrelets and bull trout and/or their prey receive. Port Angeles Harbor and nearshore areas around the action area have displayed a pattern of rapid urban expansion.

While many of the larger cities and urban areas are outside of the action area, their activities directly and indirectly affect the quality of habitat for bull trout and marbled murrelets (including prey species) within the action area. Additionally, development pressures will also likely result in a loss of vegetation and forest cover in and around Port Angeles Harbor. Conversion of privately-held timberlands to residential use is a resource concern throughout the Olympic Peninsula and much of Washington State.

## CONCLUSION

After reviewing the current status of bull trout, the population status of marbled murrelets in Conservation Zone 1, 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 or bull trout, and is not likely to destroy or adversely modify designated critical habitat for bull trout, as summarized below.

*Marbled Murrelet*

The poor breeding success of marbled murrelets is inferred from juvenile ratios determined by at-sea monitoring in Conservation Zone 1 and an adult survival estimate of 0.83 to 0.93. These datum led investigators to conclude the marbled murrelet population trend is negative (Cam et al. 2003, p. 123; McShane et al. 2004, p. 3-29). Despite this, the population of marbled murrelets in Conservation Zone 1 (Washington Inland Marine Waters) is relatively large compared to other recovery zones, with an estimated population of 4,393 (2,689 to 6,367).

Primary threats to marbled murrelets in Conservation Zone 1 are habitat loss, nest predation, and mortality in the marine environment (e.g., oil spills and commercial fisheries nets). The proposed action may cause injury of up to two individuals due to exposure to high underwater SPLs. The project will not result in habitat loss or increased nest predation; however, there is risk of mortality or physical injury of individuals from exposure to elevated underwater sound.

The Navy will implement a marbled murrelet monitoring plan within the area of potential injury and masking of vocalizations (within 168 meters of impact driving steel piles). Impact pile driving will stop when individuals are observed near or within the area of the area of injury or behavioral impacts (masking of vocalizations). Implementation of the proposed marbled murrelet monitoring protocol will reduce the potential for mortality and direct loss of most of the individuals present. However, not all birds will be detected during surveys even when they are done according to the protocol. Therefore, these measures will reduce, but not eliminate, the extent of adverse effects to marbled murrelets in the marine environment associated with exposure to injurious levels of underwater sound and behavioral impacts. Marbled murrelet abundance in Port of Port Angeles Harbor is highly variable and it is impossible to predict the number of birds that would be present and/or exposed.

When individual marbled murrelets are detected within 168 meters of pile driving, pile driving will stop until they have left the area, thus reducing the potential for adverse effects. While we expect there will be measurable effects to a small number of individuals, we do not expect that the effects of the action will measurably reduce numbers, reproduction, and/or distribution of marbled murrelets at the scale of the conservation zone. Therefore, we do not anticipate that the proposed action will appreciably reduce the likelihood of survival and recovery of the marbled murrelet rangewide.

*Bull Trout*

This project could affect bull trout from the Dungeness and Elwha core areas in this Coastal Recovery Unit. This project will result in the loss of approximately 745 square feet of eelgrass and impact another approximately 4,260 square feet of eelgrass due to shading from the access trestle. Eelgrass is important habitat for bull trout forage species. The project will cause mortality or physical injury of individuals within 736 meters of impact pile driving steel piles. Bull trout that are present within the zone of injury will be exposed to underwater SPLs and will experience significant disruptions to their normal behaviors from elevated underwater sound that may result in missed foraging opportunities, interruption of migration, and/or deterring them from using the action area. The Service expects that these effects will result in measurable physiological, biological, or behavioral effects to individuals.

The primary threat to bull trout in the Coastal Recovery Unit is habitat loss/degradation. We anticipate there will be measurable effects to individuals and habitat; however, we do not anticipate that the effects of the action will measurably affect reproduction and survival, or that the effects of the action combined with cumulative effects will result in measurable adverse effects at the scale of the Coastal Recovery Unit by reducing population abundance or distribution of bull trout. Additionally, we do not expect the cumulative effects to bull trout at the scale of the Coastal Recovery Unit would measurably affect the abundance of the Coastal Recovery Unit or the abundance of bull trout at the scale of the conterminous range.

Project-related impacts to bull trout from the Dungeness and Elwha River core areas are unlikely to be measurable at the scale of the Coastal Recovery Unit of bull trout. At the time of the analysis for the 5-year review after listing the Dungeness River core area population was considered "High Risk" and the Elwha River core area was considered "At Risk" because the threats were considered substantial and imminent (USFWS 2008, p. 29, 35). Work will occur during the approved in-water work window, when bull trout are less likely to be present in marine waters because they are migrating to spawning areas and food resources are more limited in marine areas during the time of year when construction will occur. Not all adults and subadults spawn, however, and we expect some individuals from both core areas to be adversely affected by the project. Although some individuals may be injured or killed from project-related effects, we do not expect that the loss of a small number of individuals would measurably reduce the overall population abundance at the scale of the core areas or the Coastal Recovery Unit.

*Bull Trout Critical Habitat*

Bull trout critical habitat in the action area is already impacted from shoreline development and its effects to intertidal habitat. The project will include the construction of a new pier and floats that will result in an increase of 25,456 square feet of overwater structure. The long-term presence and operation of the pier and floats will result in the loss of the shoreline function and processes and habitat complexity (PCE 4) in the nearshore. The project will result in a loss of approximately 745 square feet of eelgrass and impact another approximately 4,260 square feet of eelgrass due to shading from the overwater structure. The primary threats to bull trout critical habitat in the marine environment in Coastal Recovery Unit are future development and bank armoring. The proposed action will add new structures, including a new sheet pile retaining wall, and will result in a measurably change to the condition of critical habitat in the action area. The proposed action will not adversely modify critical habitat for bull trout but will result in measureable adverse effects to the shoreline (PCE 4) in the action area.

## INCIDENTAL TAKE STATEMENT

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

The measures described below are non-discretionary, and must be undertaken by the Navy so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The Navy has a continuing duty to regulate the activity covered by this incidental take statement. If the Navy fails to assume and implement the terms and conditions or 2) fails 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 Navy must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR 402.14(i)(3)].

## AMOUNT OR EXTENT OF TAKE

### Marbled Murrelet

The Service anticipates that up to one foraging group of marbled murrelets, not detected during surveys within 92 meters from impact pile driving activities, would be incidentally taken as a result of this proposed action in the form of harm from exposure to high underwater SPLs. The same foraging group would be incidentally taken in the form of harassment from increased in-air sound levels that would result in a significant disruption of normal behavior (masking of marbled murrelet communication) if they are in the area between 92 and 168 meters from pile driving. We anticipate that the incidental take from the proposed action will occur intermittently between July 16 and February 15.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-712), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

**Bull Trout**

The Service anticipates all sub-adult and adult bull trout within 736 meters from impact pile driving steel piles would be incidentally taken as a result of this proposed action in the form of harm. This incidental take will occur as a direct effect of exposure to elevated underwater SPLs resulting from impact pile driving when approximately 224 permanent and temporary steel piles would be installed between December 1, 2016 and February 15, 2017.

The Service anticipates incidental take in the form of injury of bull trout will be difficult to detect for the following reason(s): 1) they are underwater and may sink if injured or killed; 2) the low likelihood of finding a dead or impaired specimen; and 3) the large area of impact (total cumulative area of 170 acres). However, the level of take of this species can be characterized by the maximum area of exposure. The duration of the project, size of the area, and migratory nature of bull trout makes it difficult to quantify take by number of individuals and we therefore use area of impact as a surrogate.

## EFFECT OF THE TAKE

In this Opinion the Service determined that this level of anticipated take is not likely to result in jeopardy to the marbled murrelet or bull trout or destruction or adverse modification of bull trout critical habitat.

## REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures (RPM) are necessary and appropriate to minimize impacts of incidental take of marbled murrelets and bull trout:

1. RPM 1: Monitor incidental take of marbled murrelets caused by exposure to underwater and in-air SPLs associated with impact pile driving.

## TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the Navy 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 Navy will develop a Marbled Murrelet Monitoring Program, based off of the Service's Marbled Murrelet Monitoring Protocol (attached), with approval by the Service, to be implemented prior to any impact pile driving activities. Monitoring of marbled murrelets will occur by boat out to 92 meters (area of injury) and out to 168 meters (masking area from increased in-air sound levels).
2. The applicant will document the duration and frequency of shut downs of impact pile driving due to presence of marbled murrelets and/or sea-state conditions exceeding a Beaufort Sea State 2 within the area of injury/masking (92 meters for injury, 168 meters for masking). Should shutdowns occur at a frequency that is significantly affecting the project's schedule for completion, the Navy and the Service will work together to develop an adaptive strategy, identifying and agreeing to criteria and timelines for implementing the strategy.
3. The applicant shall provide a copy of the Marbled Murrelet Monitoring Report to the Service's consulting biologist (Jim Muck, 360-753-9586) within 90 days of the completion of the in-water work during the applicable construction year.

The Service expects that take of marbled murrelets will occur within the monitoring areas even with surveys because on-the-water monitoring for marbled murrelets is not 100 percent effective; monitoring efficiency decreases as the area of the monitoring zone increases in size. We do not expect that take of marbled murrelets can be entirely avoided even with the proposed monitoring. Birds that are within 168 meters of pile driving and not detected during surveys will be exposed to elevated underwater sound and will be taken in the form of injury or significant disturbance (harassment associated with interrupted vocalizations). Marbled murrelets within 168 meters of impact pile driving and not detected in surveys will also be exposed to elevated in-air sound and experience a measurable reduction in foraging efficiency and will be taken in the form of harassment. Bull trout within 736 meters of the pile driving that are exposed to elevated underwater sound will be injured or killed (take in the form of harm). Take could be minimized by using a properly designed bubble curtain, as proposed. Hydroacoustic monitoring will accompany the bubble curtain use; therefore, we expect that use of the bubble curtain will reduce the distance of potential adverse effects from elevated underwater sound; however, the level of attenuation will vary depending on the location of pile installation. When hydroacoustic monitoring data are available that verifies the effectiveness of bubble curtain use, the extent of the area of injury and associated take estimation can be adjusted.

If, during the course of the action, take exceeds the amounts covered under this Opinion then consultation needs to be reinitiated and the reasonable and prudent measures will need to be reviewed. Take is based on the expected areas of injury; if these areas of injury are larger than this consultation has considered, the federal action agency must contact the Services and discuss reinitiation of the consultation to address effects that were not considered in this Opinion. The federal action agency must immediately provide an explanation of what caused the take and review with the Service how to best modify the reasonable and prudent measures to avoid future potential take.

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

## CONSERVATION RECOMMENDATIONS

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

Recovery of marbled murrelets and bull trout will require efforts to restore natural shoreline processes in degraded habitats and to improve industrial, development, forestry, and agricultural practices that degrade water and habitat quality. Removing or redesigning intertidal fill and bank armor can restore shoreline habitat and reduce impacts to habitats for marbled murrelets and bull trout and their prey resources.

Ediz Hook is a natural sand spit that has been armored extensively. New infrastructure built on the spit, including the Navy's new transit protection pier, further limits opportunities for restoration of natural shorelines on the spit. With the removal of the dams on the Elwha that is allowing natural recruitment of sediments to the spit, the Service encourages the Navy to work with the Tribes, U.S. Army Corps of Engineers and resource agencies to find opportunities to restore natural processes along the spit in the future.

## REINITIATION NOTICE

This concludes formal consultation on the action(s) outlined in the request. 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:
# STATUS OF THE SPECIES: MARBLED MURRELET

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## Appendix A
## 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).

[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.

Summary: Murrelet Abundance, Distribution, Trend, and Reproduction

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).

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 20$^{th}$ 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.

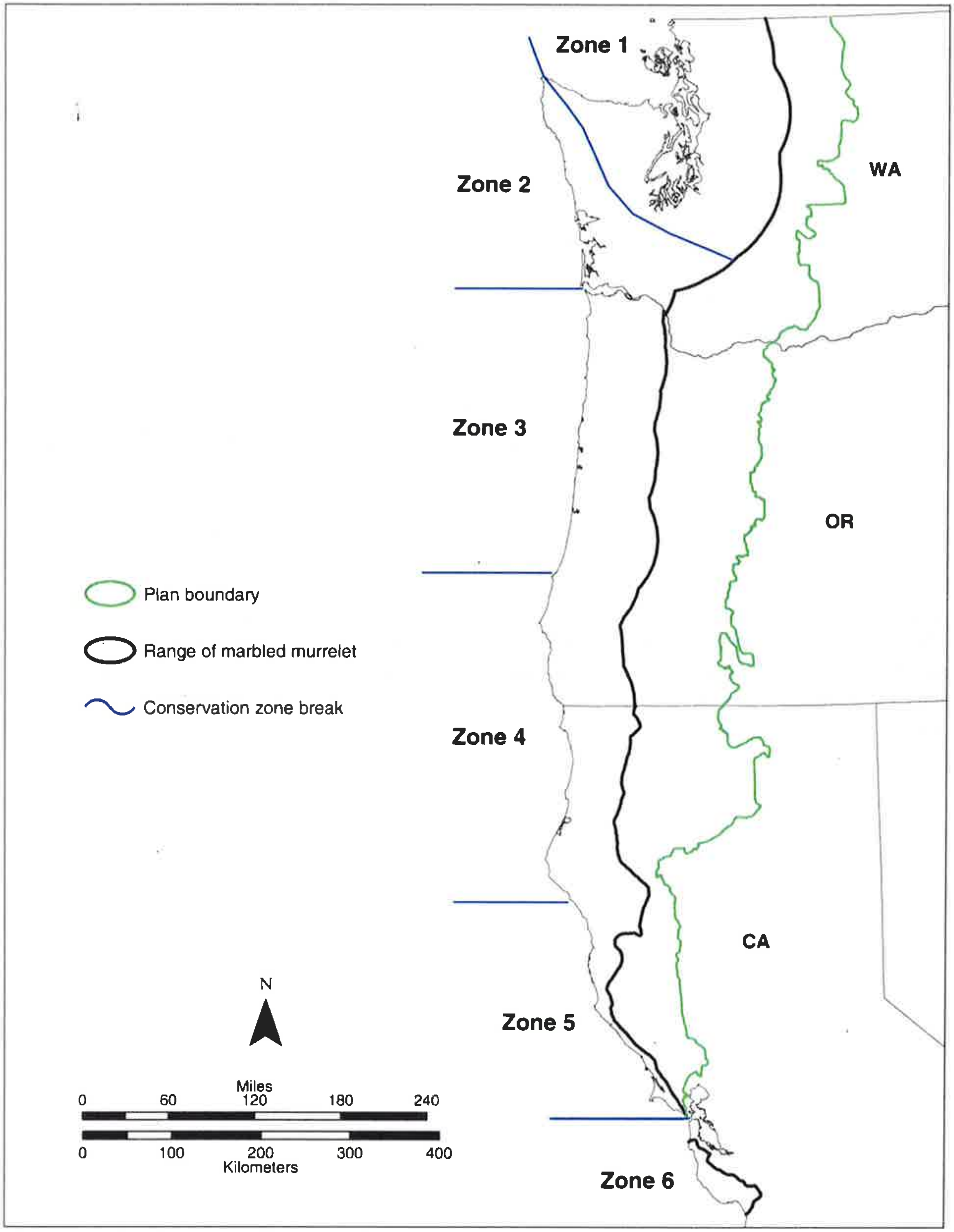


Figure 1. The six geographic areas identified as Conservation Zones in the recovery plan for the marbled murrelet (USFWS 1997). Note: "Plan boundary" refers to the Northwest Forest Plan. Figure adapted from Huff et al. (2006, p. 6).

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# APPENDIX B
# STATUS OF THE SPECIES: BULL TROUT

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## Appendix B
## Status of the Species: Bull Trout

### Listing Status

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (64 FR 58910). Bull trout generally occur in the following areas: 1) Klamath River Basin of south-central Oregon; 2) the Jarbidge River in Nevada; 3) the Willamette River Basin in Oregon; 4) Pacific Coast drainages of Washington, including Puget Sound; 5) major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and, 6) the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Bond 1992, p. 2; Brewin and Brewin 1997, p. 215; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 716-719).

Throughout its range, bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 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, pp. 6672-6673; Rieman et al. 2007, p. 1552). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (63 FR 31647; 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the Endangered Species Act (Act) relative to this species (64 FR 58910):

> Although this rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as interim recovery units with respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process.

### Recovery Planning

Between 2002 and 2004, three separate draft bull trout recovery plans were completed. In 2002, a draft recovery plan that addressed bull trout populations within the Columbia, Saint Mary-Belly, and Klamath River basins (USFWS 2002) was completed and included individual chapters for 24 separate recovery units. In 2004, draft recovery plans were developed for the

Coastal-Puget Sound drainages in western Washington, including two recovery unit chapters (USFWS 2004), and for the Jarbidge River in Nevada (USFWS 2004). None of these draft recovery plans were finalized, but they 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 U.S. Fish and Wildlife Service (Service) released a final bull trout recovery plan in September 2015 (USFWS 2015). The recovery plan: 1) incorporates and builds upon new information found in numerous reports and studies regarding bull trout life history, ecology, etc., including a variety of implemented conservation actions, since the draft 2002 and 2004 recovery planning period; and, 2) revises recovery criteria proposed in the 2002 and 2004 draft recovery plans to focus on effective management of threats to bull trout at the core area level, and de-emphasize achieving targeted point estimates of abundance of adult bull trout (demographics) in each core area.

The 2002 and 2004 draft recovery plans provide the general life history information, habitat characteristics, diet, reasons for decline, and distribution and abundance of the different core areas. The 2015 final recovery plan integrates new information collected since the 1999 listing regarding bull trout life history, distribution, demographics, conservation successes, etc., and updates previous bull trout recovery planning efforts across the range of the single DPS currently listed under the Act. The 2015 final recovery plan supersedes and replaces the previous draft recovery plans; however, the 2002 and 2004 draft recovery plans still provide important information on bull trout status and life history.

The 2015 recovery plan establishes four categories of recovery actions for bull trout:

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 non-native fishes and other non-native 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.

**Current Status and Conservation Needs**

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 recovery units (RUs): 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. 36). These are viable recovery units that meet the three primary principles of biodiversity: representation (conserving the breadth of the genetic makeup of the species to conserve its adaptive capabilities); resilience (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to provide a margin of safety for the species to withstand catastrophic events) (USFWS 2015, p. 33).

Each of the six RUs 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 600 or more local populations. 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.

Core areas can be further described as complex or simple. Complex core areas contain multiple bull trout local populations, are found in large watersheds, have multiple life history forms, and have migratory connectivity between spawning and rearing habitat and foraging, migration, and overwintering habitats (FMO). 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. A local population is the smallest group of fish 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.

The habitat requirements of bull trout are often generally expressed as the four "Cs": cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout throughout all hierarchical levels.

**Recovery Units**

The following is a summary of the description and current status of bull trout within the six RUs. More comprehensive discussions can be found in the 2015 final bull trout recovery plan (USFWS 2015) and the individual RU implementation plans.

<u>Coastal Recovery Unit</u>

The Coastal RU is located within western Oregon and Washington. The Coastal RU is divided into three regions: Puget Sound, Olympic Peninsula, and the Lower Columbia River Regions. This RU contains 21 occupied core areas and 85 local populations, including the Clackamas River core area where bull trout had been extirpated and were reintroduced in 2011. This RU also contains four historically occupied core areas that could be re-established with bull trout. Core areas within Puget Sound and the Olympic Peninsula currently support the only anadromous local populations of bull trout. This RU also contains ten shared FMO habitats that are outside core areas but that allow for the continued natural population dynamics in which the core areas have evolved. There are four core areas within the Coastal RU that have been identified as current population strongholds: Lower Skagit, Upper Skagit, Quinault River, and Lower Deschutes River. These are the most stable and abundant bull trout populations in the RU. The current condition of bull trout in this RU is attributed to: the adverse effects of climate change; loss of functioning estuarine and nearshore marine habitats; residential, commercial, and industrial development and urbanization 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); connectivity impairment and fish passage obstructions (e.g., dams, culverts, instream flows); forest management practices (e.g., timber harvest and associated road building activities); mining; and the introduction of non-native species. Conservation measures or recovery actions implemented include relicensing of major hydropower facilities that have improved 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 RU is located in southern Oregon and northwestern California. The Klamath RU 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. This RU currently contains three occupied core areas and eight local populations. Nine historic local populations of bull trout have been extirpated, and restoring additional local populations will be necessary to achieve recovery. All three core areas have been isolated from other bull trout populations for the past 10,000 years. The current condition of bull trout in this RU 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 RU is located within eastern Washington, eastern Oregon, and portions of central Idaho. The Mid-Columbia RU is divided into four geographic regions: Lower Mid-Columbia, Upper Mid-Columbia, Lower Snake, and Mid-Snake Geographic Regions. This IRU contains 25 occupied core areas, two historically occupied core areas, one research needs area, and seven FMO habitats. The current condition of the bull trout in this RU is attributed to the adverse effects of climate change, agricultural practices (e.g. irrigation, water withdrawals, livestock grazing), fish passage barriers (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.

Upper Snake Recovery Unit

The Upper Snake RU is located in central Idaho, northern Nevada, and eastern Oregon. The Upper Snake RU is divided inoto seven geographic regions: Salmon River, Boise River, Payette River, Little Lost River, Malheur River, Jarbidge River, and Weiser River. This RU contains 22 occupied core areas and 206 local populations, with almost 60 percent being present in the Salmon River Region. The current condition of the bull trout in this RU 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.

Columbia Headwaters Recovery Unit

The Columbia Headwaters RU is located in western Montana, northern Idaho, and the northeastern corner of Washington. The Columbia Headwaters RU is divided into five geographic regions: Upper Clark Fork, Lower Clark Fork, Flathead, Kootenai, and Coeur d'Alene Geographic Regions. This RU contains 35 occupied core areas: 15 complex core areas represented by larger interconnected habitats, and 20 simple core areas comprising 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. Fish passage improvements within the RU have reconnected previously fragmented habitats. The current condition of bull trout in this RU is attributed to the adverse effects of climate change, mining and contamination by heavy metals, nonnative species, 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. Unlike the other RUs, the Columbia Headwaters RU does not have any anadromous fish overlap. Therefore, bull trout within the Columbia Headwaters RU do not benefit from the recovery actions for salmon.

Saint Mary Recovery Unit

The Saint Mary RU is located in Montana but is heavily linked to downstream resources in southern Alberta, Canada. Most of the watershed in this RU is located in Canada. The United States portion includes headwater spawning and rearing habitat and the upper reaches of FMO habitat. This RU contains four occupied core areas, and eight local populations. The current condition of bull trout in this RU is attributed to the adverse effects of climate change, the Saint Mary Diversion operated by the Bureau of Reclamation (e.g., entrainment, fish passage, instream flows), and nonnative species. The primary issue precluding bull trout recovery in this RU relates to impacts of water diversions, specifically at the Bureau of Reclamations Milk River Project.

## Life History

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, pp. 1-18). 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 (Fraley and Shepard 1989, p. 1; Goetz 1989, pp. 15-16). 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, pp. 135-137; Goetz 1989, pp. 22-25), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978, pp. 139, 165-68; McPhail and Baxter 1996, p. 14; WDFW et al. 1997, pp. 17-18, 22-26). 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, pp. 135-137; Leathe and Graham 1982, p. 95; Pratt 1992, p. 6; Rieman and McIntyre 1996, p. 133).

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require adult and subadult 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 adult passage upstream). Therefore, 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 for adults and subadults. 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, pp. 29-32; Pratt 1984, p. 13). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

## Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, p. 7). 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, pp. 137, 141; Goetz 1989, pp. 19-26; Bond in Hoelscher and Bjornn 1989, p. 57; Howell and Buchanan 1992, p. 1; Pratt 1992, p. 6; Rich 1996, pp. 35-38; Rieman and McIntyre 1993, pp. 4-7; Rieman and McIntyre 1995, pp. 293-294; Sedell and Everest 1991, p. 1; Watson and Hillman 1997, pp. 246-250). Watson and Hillman (1997, pp. 247-249) 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, p. 7), bull trout should not be expected to simultaneously occupy all available habitats (Rieman et al. 1997, p. 1560).

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Gilpin, in litt. 1997, pp. 4-5; Rieman and McIntyre 1993, p. 7; Rieman et al. 1997, p. 1114). 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. 7; Spruell et al. 1999, pp. 118-120). 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 (below 15 °C or 59 °F), and spawning habitats are generally characterized by temperatures that drop below 9 °C (48 °F) in the fall (Fraley and Shepard 1989, p. 133; Pratt 1992, p. 6; Rieman and McIntyre 1993, p. 7).

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 (Baxter et al. 1997, pp. 426-427; Pratt 1992, p. 6; Rieman and McIntyre 1993, p. 7; Rieman et al. 1997, p. 1117). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C (35 °F to 39 °F) whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (46 °F to 50 °F) (Buchanan and Gregory 1997, pp. 121-122; Goetz 1989, pp. 22-24; McPhail and Murray 1979, pp. 41, 50, 53, 55). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C (46 °F to 48 °F), within a temperature gradient of 8 °C to 15 °C (4 °F to 60 °F). In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003) 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 (52 °F to 54 °F).

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, pp. 121-122; Fraley and Shepard 1989, pp. 135-137; Rieman and McIntyre 1993, p. 2; Rieman and McIntyre 1995, p. 288; Rieman et al. 1997, p. 1114). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 8 °C to 20 °C (46 °F to 68 °F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Gamett, pers. comm. 2002).

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, pp. 135-137; Goetz 1989, pp. 22-25; Hoelscher and Bjornn 1989, p. 54; Pratt 1992, p. 6; Rich 1996, pp. 35-38; Sedell and Everest 1991, p. 1; Sexauer and James 1997, pp. 367-369; Thomas 1992, pp. 4-5; Watson and Hillman 1997, pp. 247-249). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993, p. 7). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, pp. 367-369). 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, pp. 135-137; Pratt 1992, p. 6; Pratt and Huston 1993, pp. 70-72). Pratt (1992, p. 6) indicated that increases in fine sediment reduce egg survival and emergence.

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. 135). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, p. 15; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 8). 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 (Ratliff and Howell 1992 in Howell and Buchanan 1992, pp. 10, 15; Pratt 1992, pp. 5-6).

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) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). In a laboratory study conducted in Canada, researchers found that low oxygen levels retarded embryonic development in bull trout (Giles and Van der Zweep 1996, pp. 54-55). 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). 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). 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.

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes, or nearshore marine habitat where foraging opportunities may be enhanced (Brenkman and Corbett 2005, pp. 1073, 1079-1080; Frissell 1993, p. 350; Goetz et al. 2004, pp. 45, 55, 60, 68, 77, 113-114, 123, 125-126). 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). 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. 15-16; Rieman and McIntyre 1993, pp. 18-19; MBTSG 1998, pp. iv, 48-50; USFWS 2004a, Vol. 2, p. 63). 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 fish with higher fecundity is lost (Rieman and McIntyre 1993, pp. 1-18).

**Diet**

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, because this strategy can change as the fish progresses from one life stage to another (i.e., juvenile to subadult). Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994), and as fish grow, their foraging strategy changes as their food changes, in quantity, size, or other characteristics. 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. 239-243; Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout feed on various fish species (Brown 1994, p. 21; Donald and Alger 1993, p. 242; Fraley and Shepard 1989, p. 135; Leathe and Graham 1982, p. 95). Bull trout of all sizes other than fry have been found to eat fish up to half their length (Beauchamp and VanTassell 2001). Bull trout may feed heavily on fish eggs in watersheds shared with anadromous salmon (Lowery and Beauchamp 2015). 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. 114; 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. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one source of food over another. For example, prey often occur in concentrated patches of abundance ("patch model") (Gerking 1994). As the predator feeds in one patch, the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. 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). 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, p. 1079; Goetz et al. 2004, pp. 36, 60).

**Effects of Climate Change on Bull Trout**

The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "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 2007, p. 78). 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 2007, p. 78). 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, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19).

Climate change is likely to play an increasingly important role in determining the abundance of ESA-listed species and the conservation value of designated critical habitats in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early spring will be less affected. Low-elevation areas are likely to be more affected. During the last century, average regional air temperatures increased by 1.5 °F, with increases as much as 4 °F in isolated areas (USGCRP 2009). Average regional temperatures are likely to increase an additional 3 °F to 10 °F over the next century (USGCRP 2009). Overall, about one-third of the current cold-water fish habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (USGCRP 2009).

Precipitation trends during the next century are less certain than for temperature, but more precipitation is likely to occur during October through March, less may occur during summer months, and more winter precipitation is likely to fall as rain rather than snow (ISAB 2007; USGCRP 2009). Significant reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest is predicted over the next 50 years (Mote and Salathé 2010) – changes that will shrink the extent of the snowmelt-dominated habitat available to salmonids. Where snow occurs, a warmer climate will cause earlier runoff, which will increase flows in early spring but will likely reduce flows and increase water temperature in late spring, summer, and fall (ISAB 2007; USGCRP 2009).

As the snow pack diminishes and seasonal hydrology shifts to more frequent and severe early large storms, stream flow timing and increased peak river flows may limit salmonid survival (Mantua et al. 2010). Lower stream flows and warmer water temperatures during summer will degrade summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites (USGCRP 2009). To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of cold water refugia (Mantua et al. 2010). Other adverse effects are likely to include altered migration patterns, accelerated embryo development, premature emergence of fry, variation in quality and quantity of tributary rearing habitat, and increased competition and predation risk from warm-water, non-native species (ISAB 2007).

The earth's oceans are also warming, with considerable interannual and inter-decadal variability superimposed on the longer-term trend (Bindoff et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmonids, while cooler ocean periods have coincided with relatively high abundances (Scheuerell and Williams 2005; Zabel et al. 2006; USGCRP 2009). Ocean conditions adverse to salmonids may be more likely under a warming climate (Zabel et al. 2006).

Ocean acidification resulting from the uptake of carbon dioxide by ocean waters threatens corals, shellfish, and other living things that form their shells and skeletons from calcium carbonate (Orr et al. 2005; Feely et al. 2012). Such ocean acidification is essentially irreversible over a time scale of centuries (Royal Society 2005). Increasing carbon dioxide concentrations are reducing ocean pH and dissolved carbonate ion concentrations, and thus levels of calcium carbonate saturation. Over the past several centuries, ocean pH has decreased by about 0.1 (an approximately 30 percent increase in acidity) and is projected to decline by another 0.3 to 0.4 pH units (approximately 100 to 150 percent increase in acidity) by the end of this century (Orr et al. 2005; Feely et al. 2012). As aqueous carbon dioxide concentrations increase, carbonate ion concentrations decrease, making it more difficult for marine calcifying organisms to form biogenic calcium carbonate needed for shell and skeleton formation. The reduction in pH also affects photosynthesis, growth, and reproduction of marine organisms. The upwelling of deeper ocean water deficient in carbonate, and thus potentially detrimental to the food chains supporting juvenile salmonids, has recently been observed along the U.S. west coast (Feely et al. 2008).

Climate change is expected to make recovery targets for ESA-listed species more difficult to achieve. Actions improving freshwater and estuarine habitats can offset some of the adverse impacts of climate change. Examples include restoring connections to historical floodplains and estuarine habitats, protecting and restoring riparian vegetation, purchasing or applying easements to lands that provide important cold water or refuge habitat, and leasing or buying water rights to improve summer flows (Battin et al. 2007; ISAB 2007).

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# APPENDIX C
# STATUS OF THE DESIGNATED CRITICAL HABITAT FOR BULL TROUT

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**Appendix C**
**Status of the Designated Critical Habitat for Bull Trout**

## Legal Status

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 (70 FR 63898); the rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on our website (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species' coterminous range, including six draft recovery units [Mid-Columbia, Saint Mary, Columbia Headwaters, Coastal, Klamath, and Upper Snake (75 FR 63927)]. The Service's 1999 coterminous listing rule identified five interim recovery units (50 CFR Part 17, pg. 58910), which includes the Jarbidge River, Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as interim recovery units). Our five year review recommended re-evaluation of these units based on new information (USFWS 2008, p. 9). In August, 2015, the Service finalized the Bull Trout Recovery Plan defining six recovery units: 1) Coastal Recover 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 {{17449 USFWS 2015/f, p. 23;}}. The adverse modification analysis in this biological opinion does not rely on recovery units, relying instead on the listed critical habitat units and subunits.

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 (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. 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, references to PCEs should be viewed as synonymous with PBFs. Either term characterizes the key components of critical habitat that provide for the conservation of the listed species.

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 by state.

| 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 | 2,835.9 | 4,563.9 | 30,255.5 | 12,244.0 |
| Oregon/Idaho | 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** | 19,729.0 | 31,750.8 | 488,251.7 | 197,589.2 |

The 2010 revision increased 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.

This rule also identified and designated 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 excluded and exempted 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 (ESA), in which bull trout is a covered species on or before the publication of this final rule; 2) specific waters associated with the Lewis River Hydroelectric Projects; 3) 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; 4) waters adjacent to military installations that are subject to an integrated natural resources management plan (INRMP); or 5) waters where impacts to national security have been identified (75 FR 63898). 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 or exempted area is identified in the relevant Critical Habitat Unit (CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. See Tables 2 and 3 for the list of excluded areas. 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.

Table 2. Stream/shoreline distance excluded or exempted from bull trout critical habitat based on Tribal ownership or other plans.

| Ownership and/or Plan | Kilometers | Miles |
|---|---|---|
| Lewis River Hydro Conservation Easements | 7.0 | 4.3 |
| DOD – Dabob Bay Naval | 23.9 | 14.8 |
| HCP – Cedar River (City of Seattle) | 25.8 | 16.0 |
| HCP – Washington Forest Practices Lands | 1,608.30 | 999.4 |
| HCP – Green Diamond (Simpson) | 104.2 | 64.7 |
| HCP – Plum Creek Central Cascades (WA) | 15.8 | 9.8 |
| HCP – Plum Creek Native Fish (MT) | 181.6 | 112.8 |
| HCP–Stimson | 7.7 | 4.8 |
| HCP – WDNR Lands | 230.9 | 149.5 |
| Tribal – Blackfeet | 82.1 | 51.0 |
| Tribal – Hoh | 4.0 | 2.5 |
| Tribal – Jamestown S'Klallam | 2.0 | 1.2 |
| Tribal – Lower Elwha | 4.6 | 2.8 |
| Tribal – Lummi | 56.7 | 35.3 |
| Tribal – Muckleshoot | 9.3 | 5.8 |
| Tribal – Nooksack | 8.3 | 5.1 |
| Tribal – Puyallup | 33.0 | 20.5 |
| Tribal – Quileute | 4.0 | 2.5 |
| Tribal – Quinault | 153.7 | 95.5 |
| Tribal – Skokomish | 26.2 | 16.3 |
| Tribal – Stillaguamish | 1.8 | 1.1 |
| Tribal – Swinomish | 45.2 | 28.1 |
| Tribal – Tulalip | 27.8 | 17.3 |
| Tribal – Umatilla | 62.6 | 38.9 |
| Tribal – Warm Springs | 260.5 | 161.9 |
| Tribal – Yakama | 107.9 | 67.1 |
| INRMP – Naval Radio Station Jim Creek | 1 | 0.7 |
| INRMP – Naval Station Everett | 8 | 5 |
| INRMP – Naval Air Station Whidbey Island | 16 | 10 |
| INRMP – U.S. Army Fort Lewis Installation | 27.5 | 17 |
| **Total** | 3,147.4 | 1,961.7 |

Table 3. Lake/Reservoir area excluded from bull trout critical habitat based on Tribal ownership or other plans.

| Ownership and/or Plan | Hectares | Acres |
|---|---|---|
| HCP – Cedar River (City of Seattle) | 796.5 | 1,968.2 |
| HCP – Washington Forest Practices Lands | 5,689.1 | 14,058.1 |
| HCP – Plum Creek Native Fish | 32.2 | 79.7 |
| Tribal – Blackfeet | 886.1 | 2,189.5 |
| Tribal – Warm Springs | 445.3 | 1,100.4 |
| INRMP – Bayview Acoustic Research Detachment Naval Surface Warfare Center | 7.0 | 17.3 |
| **Total** | 7,856.2 | 19,413.2 |

**Conservation Role and Description of Critical Habitat**

The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63898:63943 [October 18, 2010]). 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 final 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 Primary Constituent Elements (PCEs) 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 (Rieman and McIntyre 1993, pp. 22-23; MBTSG 1998, pp. 48-49); 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; Rieman and McIntyre 1993, pp. 22-23; MBTSG 1998, pp. 48-49); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; Rieman and McIntyre 1993, p. 23; Rieman and Allendorf 2001, p. 763; MBTSG 1998, pp. 13-16).

The Olympic Peninsula and Puget Sound CHUs are essential to the conservation of anadromous bull trout, which are unique to the Coastal Recovery Unit. These CHUs contain marine nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain PCEs that are critical to adult and subadult foraging, overwintering, and migration.

*Primary Constituent Elements for Bull Trout*

Within the designated critical habitat areas, the PCEs 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 following PCEs are essential for the conservation of bull trout.

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

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 PCE's are similar to those previously in effect under the 2005 designation. The most significant modification is the addition of a ninth PCE to address the presence of nonnative predatory or competitive fish species. Although this PCE 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 PCEs 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 PCEs 1 and 6. Additionally, all except PCE 6 apply to freshwater 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 lower 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 PCEs 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 PCEs to such an extent that the conservation value of critical habitat is appreciably reduced (75 FR 63898:63943; USFWS 2004, Vol. 1. pp. 140-193, Vol. 2, 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, pp. 4-39). 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 six Recovery Units. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (75 FR 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 (75 FR 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 (67 FR 71240). 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 (63 FR 31647, June 10 1998; 64 FR 17112, April 8, 1999).

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 PCEs, 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 anadromous 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 PCEs 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).

**Consulted on Effects for Critical Habitat**

The Service has formally consulted on the effects to bull trout critical habitat throughout its range. Section 7 consultations include actions that continue to degrade the environmental baseline in many cases. However, long-term restoration efforts have also been implemented that provide some improvement in the existing functions within some of the critical habitat units.

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# APPENDIX D
# STATUS OF BULL TROUT IN THE ELWHA CORE AREA

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**Appendix D**
**Status of Bull Trout in the Elwha River Core Area**

The Elwha River core area, part of the Coastal Recovery Unit, includes the Elwha River and its tributaries including Boulder, Cat, Prescott, Stony, Hayes Godkin, Buckinghorse, and Delabarre Creeks; Lake Mills and Lake Aldwell; and the estuary of the Elwha River. The Elwha River core area is one of two core areas on the Olympic Peninsula that drain to the Strait of Juan de Fuca.

Anadromous, fluvial, and resident life-history forms are all present within the Elwha River core area. With the removal of the Elwha River dams and resulting elimination of the reservoirs, the adfluvial life-history form that was present is reverting back to the historical fluvial and anadromous forms (Crain and Brenkman 2010, p. 16; DeHaan et al. 2011, p. 472). Prior to the dam removals, bull trout were documented spawning in the area directly above Lake Mills (approximately river mile 25) (Crain and Brenkman 2009, p. 7). Dam removal likely altered this known spawning site (Crain and Brenkman 2010, pp. 16-19, 22). Another suspected spawning location may occur in the Elwha River near the confluence of the Hayes River (Crain and Brenkman 2009, p. 7). It is anticipated that new spawning habitat/sites for bull trout will develop over time in the restored reaches. There is little habitat suitable for bull trout spawning and incubation downstream of the dams.

The Elwha River core area population is considered "at risk" for extirpation (USFWS 2008a, p. 35). The status of a bull trout core area population can be summarized by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, Vol. II, p. 135).

Number and Distribution of Local Populations

Two local populations and one potential local population are recognized within the Elwha River core area (USFWS 2015, p. A-150). One local population is located in the Elwha headwaters (upstream of Carlson Canyon) and appears to primarily consist of the resident life-history form (DeHaan et al. 2011. pp. 471-472). The other local population occupies the area downstream of Carlson Canyon and primarily contains the migratory life-history form. The Little River tributary has been identified as a potential local population, based on the availability of suitable habitat and the likelihood that this high quality spawning habitat will be utilized by migratory bull trout once the dams are removed. With only two local populations, bull trout in the Elwha River core area are considered at increased risk of extirpation and adverse effects from random naturally occurring events (USFWS 2004, Vol. II, pp. 136-137).

Adult Abundance

Bull trout abundance is not known (USFWS 2008a, p. 35). Prior to the dam removals, the numbers were assumed to be moderately low. Prior to listing, bull trout observations were limited in the Elwha River below the Elwha Dam at the WDFW Chinook rearing channel (Travers, in litt. 2002; Greg Travers, WDFW, pers. comm. in WDFW 2004, p. 149). Thirty-one bull trout, ranging in size from 250 to 620 millimeters, were documented in this section of the river during snorkel surveys in 2003 (Pess, in litt. 2003). In 2007, 215 bull trout were observed during snorkel surveys from river mile 41 to the mouth of the Elwha River (USFWS 2008b, p. 1785). There is no information on trends in abundance of Elwha River bull trout. Core areas with fewer than 1,000 spawning adults per year are at risk from genetic drift, and local populations with fewer than 100 spawning adults per year are at risk from inbreeding depression (USFWS 2004, Vol. II, pp. 137-140). Bull trout in the Elwha River core area are considered at risk from these effects until more is known about adult abundance.

The bull trout population in the Elwha River core area is considered at risk of extirpation (USFWS 2008a, p. 35). The Elwha River core area showed reduced levels of within population genetic variation when compared to larger populations from other core areas; there was no indication that the fragmentation caused by the Elwha dams has led to the evolution of genetically distinct spawning populations within the Elwha River core area (DeHaan et al. 2011, pp. 471-472).

Productivity

There has been only limited monitoring of the bull trout in the Elwha River, so no trend data is currently available. Low bull trout abundances in the Elwha River core area indicates that this population is at risk of extirpation.

Connectivity

In August, 2014, the removal of the Elwha and Glines Canyon Dams was finished. With full restoration of fish passage complete with the removal of the dams, future studies will indicate bull trout movement throughout the watershed. No barriers exist within the mainstem Elwha River and the lower reaches of its tributaries. The removal of the dams on the Elwha River has provided connectivity between the local populations within the Elwha River core area.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, federal actions occurring in the Elwha River core area have resulted in harm to, or harassment of, bull trout, many specifically related to construction activities. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and Section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. The removal of Elwha and Glines Canyon Dams, as part of the Elwha River Restoration Project, represents a federal action with long-term improvement of bull trout habitat and core population. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have also directly affected bull trout in the Elwha River core area (e.g., Crain and Hugunin 2012, pp. 3-4).

The number of non-federal actions occurring in the Elwha River core area since the bull trout listing is unknown. However, because most of the core area is in federal ownership, few non-federal actions likely have occurred in this core area.

Threats

There are four primary threats to bull trout in the Elwha River core area (USFWS 2015, pp. A-17-18).

*Instream Impacts: Fish Passage Issues* – Fish passage difficulty at former dam sites.

*Water Quality: Instream Flows* – Adequate water quantity within the lower river will need to be maintained nto the future, as municipal water rights currently exceed summer flows. Exercising full water rights will seasonally alter instream habitat and impair connectivity for migration; ongoing loss of glaciers associated with climate change is expected to exacerbate low instream flows.

*Forage Fish Availability: Preybase* - although dam removal has been completed, salmon and steelhead populations are only in the early rebuilding phase and may require additional habitat and/or fish management intervention to fully restore freshwater prey base in Elwha River watershed.

*Nonnative Fishes: Competition and Hybridization* – With the removal of the dams, brook trout now overlap tributary spawning areas for bull trout in Indian, Griff, and Hughes creeks, and Little River, creating significant potential for species competition and hybridization.

Additional threats to bull trout in the Elwha River core area include:

- Past logging on private lands in the Elwha River core area, outside of the Olympic National Park, has affected water quality through the release of fine sediment, which potentially affects bull trout egg incubation success and juvenile rearing.

- Impacts from residential and urban development occur mainly in the lower Elwha River. Dike construction has constricted the channel and severely affected nearshore and estuary habitat and processes.

- Bull trout are susceptible to incidental mortality associated with fisheries that target commercially desirable species such as coho and steelhead in the lower river and recreational fishing in Olympic National Park. There is currently a 5-year moratorium on all fishing in the Elwha River to assist with the recovery and colonization of this watershed following dam removal.

- Stranding and crushing of bull trout occurs during Port Angeles Water District's routine maintenance and repair operations.

- Most of the Elwha River watershed (85 percent) is within the Olympic National Park, which minimizes outside stressors to bull trout and their habitat. The watershed is identified as a "transient" watershed with regard to it being rain dominated versus a snowmelt dominated system. It is projected to become a rain dominated system due to climate change (Halofsky et al. 2011, p. 45). This change will result in modifications to stream flow and temperature which will cause a decline in the quality and quantity of bull trout habitat. Simulations of the monthly and average total baseflow based on global climate models indicate that average total runoff and base flow depths will increase during the fall through early spring, and decrease in the summer compared to simulated historical (Halofsky et al. 2011, p. 24). The lower summer flows will allow streams to be more influenced by increased air temperatures (ISAB 2007 in Halofsky et al. 2011, p. 44). With projected increases in air temperature, especially in the lower elevations of this core area (Halofsky et al. 2011, p. 44), water temperatures are also anticipated to increase.

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# APPENDIX E
# STATUS OF BULL TROUT IN THE DUNGENESS CORE AREA

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## Appendix E
## Status of the Bull Trout in the Dungeness River Core Area

The Dungeness River core area comprises the Dungeness and Gray Wolf Rivers, associated tributaries, and estuary. The Dungeness River core area is one of two core areas in the Coastal Recovery Unit that are connected to the Strait of Juan de Fuca. Bull trout occur throughout the Dungeness and Gray Wolf Rivers downstream of natural impassable barriers, which are present on both rivers (RM 18.7 on the Dungeness River; approximately RM 9.0 on the Gray Wolf River). Bull trout also occur in the Dungeness River estuary and Gold Creek, a Dungeness River tributary. Of 79 char known to have been sampled from anadromous reaches of the Dungeness River watershed, all but one were positively identified as bull trout via genetic analysis (Spruell and Maxwell 2002; Spruell 2006; DeHaan et al. 2011; DeHaan, in litt. 2014). Upstream of the anadromous barrier on the Dungeness River, all 50 char sampled were confirmed as Dolly Varden (*Salvelinus malma*) (Young 2001). It is likely that the Dolly Varden sampled below the falls was a fish that passed over the falls and was not able to return to its home range above the falls. Dungeness River bull trout are genetically unique from other nearby bull trout populations, including those in the Elwha and Skokomish Rivers and along the coast (DeHaan et al. 2011, pp. 468-469).

The anadromous and fluvial life-history forms occur in the Dungeness River core area (USFWS 2004, pp. 60-61; Ogg et al. 2008). Anadromy was observed in 27 percent of 48 radio tagged bull trout in 2003 and 2004 (Ogg et al. 2008, p. 19). The resident form is also likely, but has not been confirmed. Mainstem rivers within the core area provide spawning, rearing, foraging, migration, and overwintering habitats. The estuary also provides important foraging habitat. During a study in 2006 and 2007 by the Jamestown S'Klallam Tribe that targeted salmon smolts, a number of bull trout were incidentally captured in fyke nets located in estuary feeder channels and during beach seining. These fish ranged in size from 117 to 380 millimeters and were often captured in the midst of juvenile pink and chum salmon and post larval surf smelt.

Fish passage into Canyon Creek was blocked by an impassable diversion dam near its mouth from the early 1900s until March 2016, when fish passage was restored. Bull trout are not known to currently occupy Canyon Creek, but it is believed it will provide important foraging and potentially spawning and rearing habitat for bull trout (USFWS 2010, p. 19).

The Dungeness River core area population is considered at "high risk" for extirpation (USFWS 2008, p. 35; USFWS 2015b). Key status indicators have not changed since 2008; therefore, this designation is still valid. The status of the bull trout core area population can be described by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, p. 135).

### Number and Distribution of Local Populations

Two local populations - the Dungeness River and the Gray Wolf River - are recognized within the Dungeness River core area (USFWS 2004, p. 61; USFWS 2015a, p. A-150). The Gray Wolf River local population occurs in the Gray Wolf River downstream of the anadromous barrier at river mile (RM) 8.5 to the confluence with the Dungeness River (USFWS 2004, p. 61; Ogg et al.

2008, pp. 23-26). The Dungeness River local population occurs from the anadromous barrier at RM 18.7 downstream to the confluence with Canyon Creek at RM 10.8 (USFWS 2004, p. 62), although spawning has not been documented downstream of RM 15. This local population includes Gold and Canyon Creeks. Both of these local populations spawn primarily from September through November (Ogg et al. 2008, pp. 24-27). Ogg et al. (2008, pp. 23-26) observed a seemingly distinct third group, which spawned near the Gray Wolf River confluence in December. Further study and analysis is needed to determine whether this late spawning group constitutes a third local population. With only two local populations, bull trout in this core area are considered to be at increased risk of extirpation and adverse effects from random naturally occurring events (USFWS 2004, pp. 136-137).

Adult Abundance

In 2005, the USFWS concluded that the number of spawning bull trout in the Dungeness River core area appeared to be very low (USFWS 2005, p. 622), although this conclusion was based on very limited data. The USFWS 2008 Five Year Review categorized the Dungeness River core area as having 50 to 250 individuals (USFWS 2008, p. 35). In 2004, Ogg et al. (2008, p. 26) observed 17 bull trout redds in the Dungeness River between the anadromous barrier and the Gray Wolf River confluence during thirteen surveys. In the Gray Wolf River, 33 redds were observed during twelve surveys (Ogg et al. 2008, p. 26). These surveys were considered intensive and likely captured the majority of redds within the core area (USFWS 2005, p. 620), although the December spawning group was not represented (no surveys were performed in December). Surveys performed in December 2005 identified ten redds in the Dungeness and Gray Wolf Rivers within about one-half mile of the confluence (Ogg et al. 2008, pp. 26-27). There are no reasons to believe that abundance has appreciably changed since these surveys were completed. The small numbers of redds observed suggest that the adult abundance of both local populations is likely very low.

The bull trout population in this core area is one of the most depressed in the Coastal Recovery Unit. The 2015 Bull Trout Recovery Plan identifies "small population size" as one threat to this population (USFWS 2015a, p. A-17). The Dungeness River core area is at risk from genetic drift because it likely contains fewer than 1,000 spawning adults per year (USFWS 2004, pp. 137-140). Both local populations are at risk from inbreeding depression because they are believed to contain fewer than 100 spawning adults per year (USFWS 2004, pp. 137-140).

Productivity

There are limited data on bull trout productivity in the Dungeness River watershed. The Washington Department of Fish and Wildlife (WDFW) has operated a smolt trap near the mouth of the river since 2005. Bull trout catch in the trap provides the only available indicator of productivity in the watershed. Between 2005 and 2016, bull trout catch in the trap varied between 10 and 77 fish, except for 2014 when catch jumped to 148 fish (Figure 1) (Topping, in litt. 2014; Topping, in litt. 2015; WDFW 2015; Topping, in litt. 2016). These data suggest that bull trout productivity is generally low and has not varied much since 2005, the apparent increase in 2014 notwithstanding. The 148 fish captured in 2014 was a considerable increase over previous years, but was not sustained in 2015 and 2016 when catch was 16 bull trout each year.

The anomalously large catch in 2014 substantially influences the 5-year running average, suggesting a flat trend in productivity. However, the 5-year running average shows a declining trend when the 2014 data are removed. Declining productivity would place the Dungeness River core area at increased risk of extirpation (USFWS 2004, pp. 140-141). Juvenile trap data has limitations and must be used with caution. Abundance of outmigrating anadromous juveniles may not be closely correlated with adult abundance. In addition, there are no trap efficiency estimates for bull trout; therefore, catch cannot be expanded to estimate the actual number of bull trout passing the trap, nor can confidence intervals be calculated to determine statistical significance of trends. Bull trout in the Dungeness River core area are considered at risk of extirpation until sufficient information is collected to properly assess the productivity of this core area.

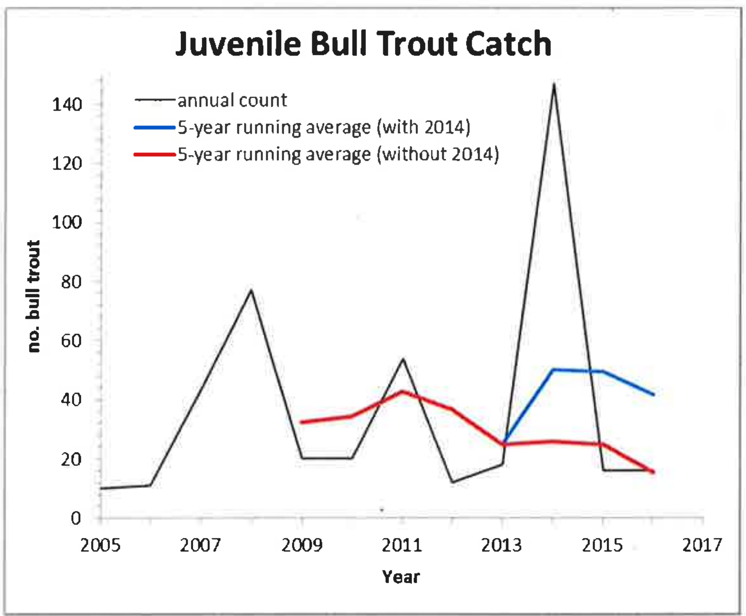


Figure 1. Catch of juvenile bull trout in the Washington Department of Fish and Wildlife's Dungeness River salmonid smolt trap located at RM 0.5. (Sources: Topping, in litt. 2014; Topping, in litt. 2015; WDFW 2015; Topping, in litt. 2016)

Connectivity

There are no dams or other large water management structures within the Dungeness or Gray Wolf Rivers affecting connectivity within the mainstems. Connectivity between the lower Dungeness River and its floodplain has been eliminated by diking to prevent flooding. Migration during late summer and early fall can be blocked by reduced flows in the lower watershed from water diversions for irrigation and municipal water supplies. Water rights in the Dungeness River basin are severely overappropriated, and, although these rights are apparently not fully utilized, they take a substantial proportion of the river flow during the natural annual low flow period from August to early November (Haring 1999, pp. 99-104; EDPU 2005, Chapter 2.3). This period overlaps the upstream and downstream migration timing of bull trout in the Dungeness River (Ogg et al. 2008). Decreased flows may inhibit passage of adult salmonids in the Dungeness River (Haring 1999, pp. 99-104), although the extent to which anthropogenically diminished flows inhibits the migration of adult bull trout has not been evaluated. Nonetheless, instream flows have been identified as a primary threat to bull trout in the Dungeness River (USFWS 2015a, p. A-17).

A number of barriers to fish movement and migration in the Dungeness River core area are due to improperly sized or installed culverts. Migration at certain times of the year may be obstructed by the WDFW fish hatchery collection weir on the lower Dungeness River. The hatchery water intake on Canyon Creek was a complete barrier to fish passage until March 2016 when the infrastructure was retrofitted with a fish ladder to provide fish passage.

Despite these impairments to connectivity, migratory bull trout persist in both local populations. The full extent to which connectivity impairments in the Dungeness River watershed directly affect bull trout reproduction, abundance, and distribution via migration delays and habitat fragmentation is not known. It appears likely that direct effects have at least some negative impact. In addition, impaired connectivity in the Dungeness watershed indirectly affect bull trout by impacting naturally-spawning salmonids (Haring 1999, pp. 85-107), a primary driver of freshwater ecosystem productivity and important forage resource for bull trout. For these reasons, bull trout in this core area are at increased risk of extirpation from impairments to connectivity.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, federal actions occurring in the Skokomish core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling during implementation of sections 6 and 10(a)(1)(A) permits under the Endangered Species Act have directly affected bull trout in the Skokomish core area.

The number of non-federal actions occurring in the Dungeness River core area since the bull trout was listed are unknown. Activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout. Conversely, non-federal salmon recovery efforts are improving conditions for bull trout. Although directed toward salmonids other than bull trout, the regional salmon recovery plan under the Shared Strategy for Puget Sound and watershed-scale implementation under the Puget Sound Partnership have resulted in general aquatic habitat improvements that are likely benefitting bull trout.

Climate change is expected to affect both river flow and water temperatures to the detriment of bull trout and other salmonids. Increases in late fall and winter flow in the Dungeness River, and decreases in the spring, summer, and early fall flow are expected (Halofsky et al. 2011, p. 25; Whited et al. 2012). Less annual snow pack and earlier loss of snow pack are predicted, which will reduce summer low flows and impact migration and rearing habitats. By 2020, a 20 percent decrease in late summer low flow is expected from pre-2006 levels. By 2080, this will reach 40 percent. This will exacerbate threats already posed by current anthropogenic water withdrawals and low flow in the lower watershed. Fall and winter storms are expected to intensify, which is likely to increase redd scour. In addition, water temperatures are expected to warm due to the projected increases in air temperature, especially in the lower elevations of this core area (Halofsky et al. 2011, p. 44). This will be exacerbated by the lower late summer flows which will increase the influence of air temperature on water temperature.

Threats

There are four primary threats to bull trout in the Dungeness River core area (USFWS 2015a, p. A-17):

*Instream Impacts: Flood Control.* Flood and erosion control associated with agricultural and residential development continues to result in poor structural complexity and high water temperatures within the lower river, a migration corridor key to the persistence of the anadromous life history form. Floodplain restoration, large wood recovery, and riparian conservation are critical needs.

*Water Quality: Altered Flows.* Agricultural and residential water use continues to result in poor instream flow and dewatering within the lower Dungeness River, impairing FMO habitat.

*Small Population Size: Genetic and Demographic Stochasticity.* Available spawner abundance data indicates the low number of adults results in increased genetic and demographic stochasticity in both the Dungeness River and Grey Wolf River local populations.

*Forage Fish Availability: Prey Base.* Depressed populations of salmon and steelhead limits the available freshwater prey base within this system even though abundance of some species (i.e., pink salmon) has significantly improved.

Additional threats to Dungeness watershed bull trout include:

- Climate change. Climate change is expected to negatively affect spawning and rearing bull trout via elevated water temperatures during migration, spawning, and rearing periods; redd scour due to increased peak flows; and decreased habitat quantity as a result of lower summer flows. Climate change will exacerbate the already problematic low flow issues caused by over-appropriated water rights.

- Fisheries. Bull trout are highly susceptible to incidental capture and mortality associated with fisheries directed at hatchery-origin coho and steelhead in the anadromous reaches of the Dungeness River watershed and Dungeness Bay. In 2003, the WDFW conducted creel surveys in the Dungeness River from mid-October through November, covering the lower watershed from the Dungeness Hatchery downriver to within one mile of the mouth. Anglers reported capturing 32 bull trout (Cooper, in litt. 2015). This likely underestimates the actual number of bull trout captured because the entire fishing season was not surveyed, surveys were not conducted on every day of the survey period, not all anglers were interviewed on each day of the survey, and the entire area open to fishing was not surveyed. The Gray Wolf recreational steelhead fishery overlaps completely the time and place of significant bull trout spawning by this local population. Illegal lethal take associated with poaching and negative perceptions by some steelhead anglers toward bull trout are also concerns.

  Dungeness River core area bull trout may also be susceptible to capture in Dungeness Bay recreational and Tribal fisheries targeting hatchery-origin coho and steelhead. The coho fisheries are generally open from mid-September through late-November; steelhead from early December through February. There are no direct empirical data on timing of bull trout movement into the Dungeness River. Adult Dungeness bull trout outmigrate from the river into marine waters primarily from May through August (Ogg et al. 2008, p. 2), which is several months later than other western Washington populations (Brenkman and Corbett 2005, pp. 1078-1079; Goetz et al. 2007, p. 18; Hayes et al. 2011, p. 394; Goetz et al., *in litt.* 2012). Assuming Dungeness River bull trout exhibit similar marine residency times as these other populations, their return through Dungeness Bay to the river mouth would occur from July through October, exposing the later returners to capture in the coho fisheries. Substantial impacts from capture in non-sport fisheries have been documented in the Hoh River (Brenkman and Corbett 2005, pp. 1077-1080).

- High anadromous mortality. Ogg et al. (2008) observed 14 tagged bull trout emigrating from the Dungeness River into the marine environment. Only one of these returned to the Dungeness River. Of those that did not return, the authors noted that half were confirmed mortalities likely due to natural predation and/or sport fishing in the estuary and lower river (Ogg et al. 2008, pp. 30-31). The rest migrated to saltwater and were never detected afterward, or were tracked to nearby watersheds (Valley Creek and Morse Creek) and confirmed deceased from unknown causes.

- Past logging and logging-related activities, such as roads, have degraded habitat conditions (e.g., fisheries, water quality, and connectivity) in the upper watershed, which has a naturally unstable geology with steep slopes that are susceptible to mass wasting.

- Past and current agricultural practices and the over appropriation of water rights negatively affect instream flow, increase water temperatures, and increase sediment deposition in the streambed. Other impacts include blocked migration, decreased juvenile rearing areas, straying into other streams, transportation of pollutants in irrigation flows, reduced amounts of large woody debris, and loss of estuarine rearing and foraging habitat.

- Water quality has been degraded by municipal, agricultural, and industrial effluent discharges and development.
- Residential and urban developments along the shore that include intertidal filling, bank armoring, and shoreline modifications have caused the loss of extensive eelgrass meadows in the nearshore.

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