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United States Department of the Interior

FISH AND WILDLIFE SERVICE

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

In Reply Refer To:
1-3-06-F-0369
X Ref: 1-3-06-I-0061

MAY 2 2007

Michelle Walker, Chief Regulatory Branch
Seattle District, Corps of Engineers
ATTN: Regulatory Branch (Perry)
P.O. Box 3755
Seattle, Washington 98124-3755

Dear Ms. Walker:

Subject: COE # 200501451; Port of Anacortes Pier 1 Upgrades

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) based on our review of the proposed upgrades to the Port of Anacortes in Skagit County, Washington, and its effects on the bull trout (*Salvelinus confluentus*) and the marbled murrelet (*Brachyramphus marmoratus*) in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). Your June 27, 2006 request for formal consultation was received on June 28, 2006.

Your effects determination for the proposed project was "may affect, likely to adversely affect" for the bull trout and the marbled murrelet; and "may affect, not likely to adversely affect" for the bald eagle (*Haliaeetus leucocephalus*).

Based on the information provided with your cover letter and the Biological Assessment, we have concluded that effects to bald eagles would be insignificant and/or discountable. Therefore, we concur with your "may affect, not likely to adversely affect" determination for this species. Specifically, our concurrence is based on the following rationale:

- The closest nest site is 1.5 miles from the Port of Anacortes (Port). Because sound levels associated with pile driving will not exceed ambient background levels at this distance, effects to nesting bald eagles are considered discountable.

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- A documented bald eagle wintering area is located approximately 0.5 mile from the project site. Bald eagles utilizing the action area for foraging and overwintering are accustomed to a wide variety of noise and activity associated with Port activities, commercial vessel construction and operation, and the urbanized setting of the action area. Although pile driving has the potential to disrupt normal wintering and foraging activities, field measurements taken at similar projects in western Washington indicate that the sound will be below 92dB (level where flushing may occur) at a distance of 0.5 mile. Thus, effects to foraging bald eagles are considered insignificant.

The enclosed BO addresses the adverse effects associated with the proposed project to bull trout and marbled murrelets and includes mandatory terms and conditions intended to minimize those adverse effects.

If you have any comments or questions regarding the BO, please contact Martha Jensen at (360) 753-9000 or Tom McDowell at (360) 753-9426, of this office.

Sincerely,

Thomas L. McDowell

for Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

cc:
NOAA-Fisheries, Sand Point (J. Moribe)
WDFW, Mill Creek (B.Williams)

Endangered Species Act – Section 7 Consultation
Biological Opinion

U.S. Fish and Wildlife Service No.
1-3-06-F-0369
X-ref: 1-3-06-I-0061

Port of Anacortes
Pier 1 Upgrades
Skagit County, Washington

Agency:

Consultation Conducted by
U.S. Fish and Wildlife Service
Western Washington Fish and Wildlife Office
Lacey, Washington

May 2007

For Ken S. Berg, Manager

Port of Anacortes
(FWS: 1-3-06-F-0369)

This document contains the U.S. Fish and Wildlife Service's (Service) Biological Opinion based on our review of the proposed facility upgrades at the Port of Anacortes Pier 1 in Skagit County, Washington, and its effects on the bull trout and the marbled murrelet in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

This Biological Opinion is based on information provided in the December 2005 Biological Assessment, as well as phone conversations and e-mails with staff at the Port of Anacortes and their consultants. A complete decisional record of this consultation is on file at this office.

CONSULTATION HISTORY

The Army Corps of Engineers (COE) is proposing to issue a permit to the Port of Anacortes (Port) for their Project Pier 1 project in Guemes Channel. The Port is proposing a number of improvements and waterway modifications to accommodate proposed expansions and operations at the Dakota Creek Industries shipyard (DCI).

These include, but are not limited to: 1) construction of three new commercial piers to create two deep water ship berths; 2) installation of a sheet pile surround around the ship berths, and 3) dredging the moorage basin and berthing areas to a mean depth of -35 ft mean lower low water (MLLW). The DCI shipyard is a major source of employment for the community and the proposed upgrades are needed to accommodate larger contracts. To offset the unavoidable loss and degradation of intertidal habitat, the proposed action includes several mitigation projects.

The COE submitted a Biological Assessment and a Memorandum for the Services (MFS) to the Service on June 28, 2006. The National Marine Fisheries Service requested information from the COE on September 19, 2006, to clarify details on the project description and the mitigation package. The applicant responded on September 20, 2006, and both Services determined that the information provided in the Biological Assessment and subsequent documents was adequate to initiate consultation.

The mitigation portion of this action was covered under the consultation for the Swinomish Channel Dredging (FWS Reference # 1-3-06-I-0061).

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The Port is proposing a number of waterway modifications to upgrade the DCI shipyard operations (Figure 1). The existing configuration of the shipyard provides limited upland space

and does not allow for drydock moorage within the ship basin, requiring vessels that are waiting for repairs to be moored at Pier 1 or Pier 2. The existing piers will be removed and replaced with larger, updated mooring facilities, resulting in a net increase of 18,200 square ft (ft^2) of new overwater structures. Approximately 168,000 cubic yards (cy^3) of material will be removed from the ship basin, resulting in approximately 3.86 acres of shallow intertidal habitat being converted to deep water habitat. In addition, approximately 1.06 acres of intertidal habitat will be filled and converted to upland habitat. To compensate for these impacts, the Port proposes to create intertidal habitat at two locations near the marine terminal, create 2.3 acres of shallow water habitat, and enlarge an existing eelgrass bed in Fidalgo Bay. The proposed action will be conducted over a period of 2 years (two work windows). Dredging will take about 22 weeks and pile driving is expected to be completed in 25 weeks.

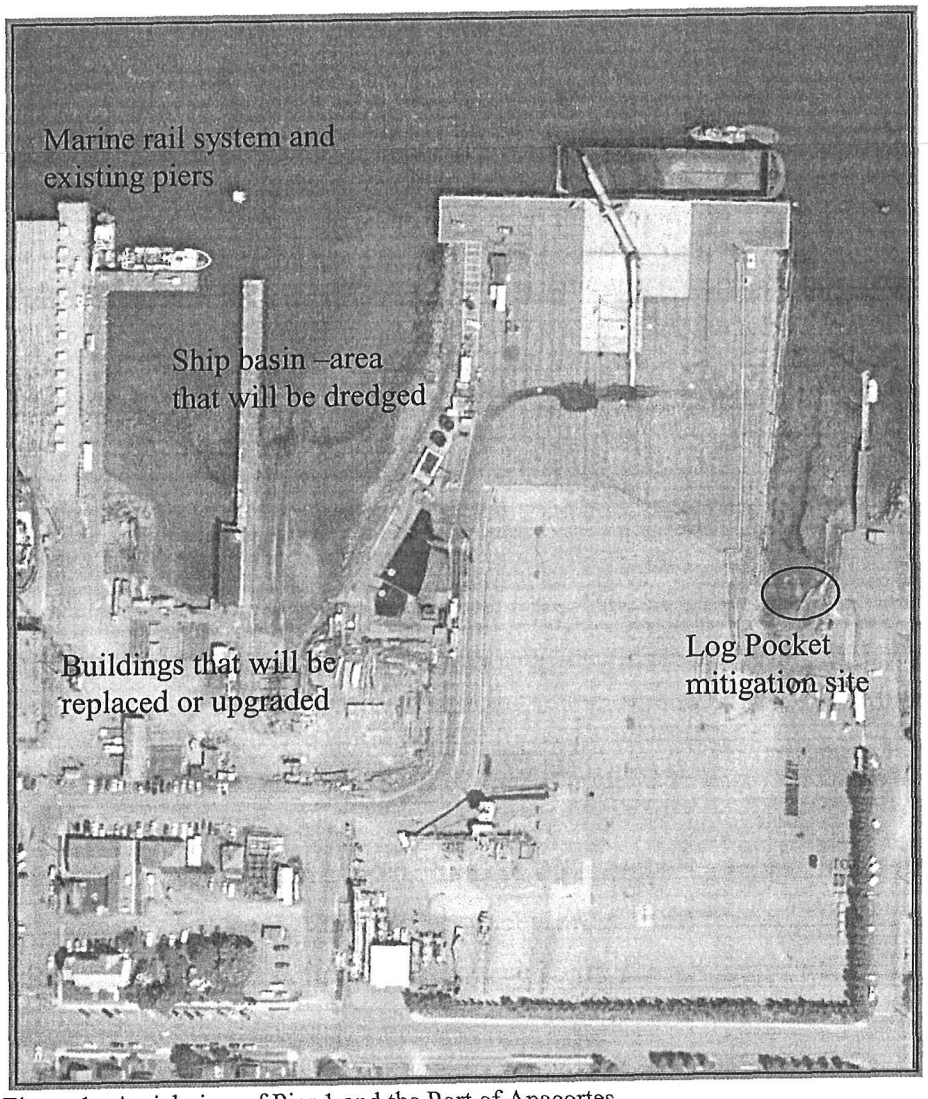

Figure 1: Aerial view of Pier 1 and the Port of Anacortes

Upland Conversion at Log Pocket and O Avenue Mitigation Sites

Two of the three mitigation sites are located in Guemes Channel, adjacent to DCI's ship basin. The first site, named the Log Pocket mitigation site, is to the east of the DCI ship basin in an area that was used for log transport and storage. All operations at the Log Pocket site have been discontinued. The proposed restoration action at this site is to remove one acre of upland fill and convert the area into an intertidal mudflat. The second mitigation site, named the O Avenue site, is located to the west of the DCI ship basin. The applicant is proposing to remove a nominal amount of upland fill (0.06 acre), a concrete pad, and a propane tank, and convert the area into intertidal habitat. The amount and timing of these mitigation actions and the eelgrass mitigation described later were negotiated by Washington Department of Fish and Wildlife (WDFW) for their Hydraulic Project Approval permit.

Removal of Existing Structures

The existing piers, which cover approximately 23,400 ft^2, are over 70 years old and are made with creosote-treated timber piles and decking. Before dredging can begin, the existing L dock, east dock, two dolphins, and a marine railway will need to be removed (Grette Associates 2005a). Removal of the onshore infrastructures will be done from land using standard construction equipment and cranes. A barge-mounted crane will be used to remove over-water structures and piles. Approximately 1,000 creosote-treated timber piles will be removed and transported to an approved upland disposal site. Piles will be pulled or cut below the mudline if they are too deteriorated to remove completely. Material from the demolished structures will be recycled or used in other portions of the piers or buildings.

Dredging

The berths will be reconfigured to accommodate modern shipyard operations, including launching and retrieval of vessels, dry dock operations, and ship repairs. Approximately 168,000 cubic yards of sediments will be removed from the basin to create a uniform depth of -35 MLLW, plus 1 foot of allowable overdredge. Sediments will be removed using a combination of barge-mounted cranes with clamshell buckets and hydraulic dredges. Material that meets the COE criteria for open water disposal will be taken to the Rosario Strait open-water dredged material disposal site. Approximately 11,500 cubic yards of contaminated top layer sediments will be taken to an approved upland disposal site.

Installation of New Bulkhead

The reconfigured berthing area and moorage basin will be stabilized with the addition of about 670 linear ft of a vertical open-cell sheet pile bulkhead. The steel bulkheads will be installed along the southern boundary and portions of the western and eastern edges of the boat basin and will be driven with a vibratory pile driver (Grette Associates 2005a). Portions of the bulkhead will be backfilled along the landward side to stabilize the surround and provide a functional upland surface area.

Installation of New Piers and Other Upland Facilities

The old piers will be replaced with three new fixed piers that are equipped with a heavy fender system on the channel side. The replacement piers (41,600 ft^2 in size) are about twice as large as the existing piers and will increase the amount of overwater structures by approximately 0.57 acres. The new piers will require installation of 260 structural steel piles (24- to 30-in diameter), 250 steel fender piles (12- to 16-in diameter), and 2 dolphins. The piles will be installed using an impact pile driver that is outfitted with a bubble curtain to attenuate sound pressures that can harm fish and other marine life. The existing marine railway will be replaced with a new lateral rail transfer system and utilities.

Transplantation of Eelgrass

The eelgrass mitigation site is located in Fidalgo Bay, approximately 4.5 miles southeast of Guemes Channel. The sheltered bay currently supports a large productive eelgrass bed. However, previous dredging within Fidalgo Bay has left some areas too deep to support eelgrass. The proposed mitigation is to fill these areas with sediments from routine maintenance dredging of the Swinomish Channel and create shallow water habitat that will support eelgrass. The outer margin of the mitigation area is defined by the -10-foot MLLW contour line, which forms the offshore margin of the adjacent portion of the existing eelgrass bed at the site. Approximately 6 acres of new shallow water area will be created for the Fidalgo Bay eelgrass mitigation bank. The applicant will plant approximately 2.3 acres of eelgrass within the mitigation site to replace the eelgrass that will be lost as a result of the port upgrades (Grette Associates 2005b).

The proposed dredging in the DCI ship basin will eliminate about 0.86 acres of eelgrass within the Guemes Channel. The eelgrass will be salvaged from the project area prior to dredging and the turions will be transplanted to the mitigation site in Fidalgo Bay. Depending on survival, the mitigation site may need to be supplemented with additional eelgrass turions from a stocked source (Grette Associates 2005b). The net mitigation will result in a 1.5 to 1 replacement ratio.

Monitoring

Monitoring is required for all mitigation components as part of the WDFW hydraulic permit. The Log Pocket and O Avenue mitigations sites will be monitored for 6 years and eelgrass recovery will be tracked for 10 years at the Fidalgo Bay mitigation site (Grette Associates 2005b). Monitoring methodology will include "physical monitoring" to evaluate the structure of the habitat and biological sampling to measure its effectiveness and value as fish habitat. Photo points and transects will be used for physical monitoring and floating beach seines will be used to collect fish at the Log Pocket and O Avenue sites. Measurements at the Fidalgo Bay site will include bathymetry surveys, extent of eelgrass growth and coverage, and turion counts to determine survival. These will be used as a surrogate for fish and epibenthic surveys. The Port will send an "as-built" report after construction and an annual monitoring report to the COE (Grette Associates 2005a). The Port has also submitted a contingency plan for taking action if

mitigation sites fail to meet performance standards. These actions include replacing or reinforcing slumping graded or filled areas and replanting eelgrass.

Timing

In-water work (pier and piling replacement, dredging, bulkhead installation, fill) is scheduled to begin on July 16, 2007, and will be completed over the course of two work windows (2 years), ending around February 15, 2009. The first phase of construction, scheduled to start in 2007, consists of removing the existing piers and buildings. Once the decking and over 1,000 pilings have been pulled, approximately 500 new piles will be installed. Most of the removal activities will occur during the first year (2007/2008 in-water work window). Some dredging, pile installation, and upland work may be started during the first year. The majority of pile driving, dredging, and pier construction will occur during the second work window (2008/2009). Replacement of buildings, the marine rail system, utilities, and other upland work will be

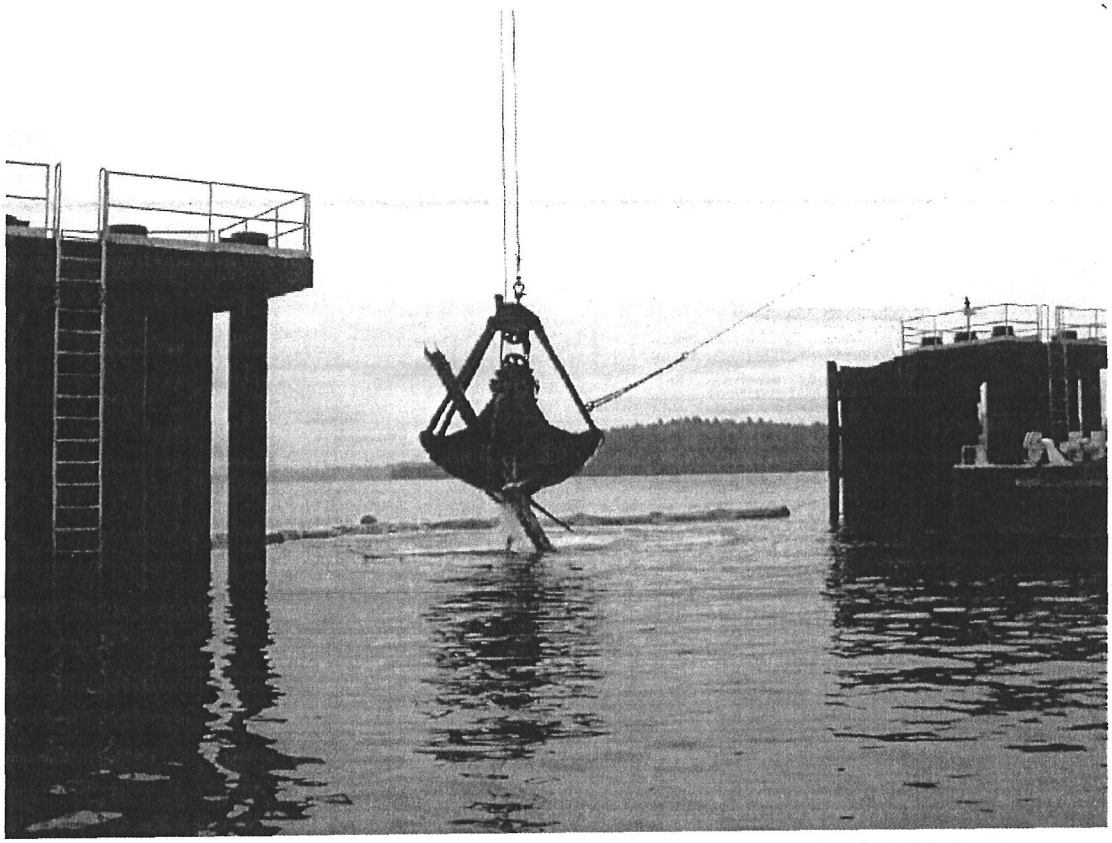

Figure 2: Clamshell bucket removing pile stubs at the Anacortes Ferry Terminal in 2003 (Anchor Environmental,L.L.C. 2004).

Stormwater Treatment

The project will add approximately 18,200 ft^2 of new impervious surface. According to the National Pollution Discharge Elimination Permit (WDOE 2006), the discharge of chemicals, oils, and contaminants into waters of the state is prohibited. All stormwater, wastewater, and chemical residues from the shipyard will be treated at the wastewater treatment plant in Anacortes. The project will also require a construction stormwater general permit from the Department of Ecology.

Street Improvements and Access

Upland improvements include reconfiguring the vehicle entrance off R Avenue, adding 138 new vehicle parking spaces, providing a viewing area, interpretive signs, and pedestrian access to the beach at the mitigation sites, and right-of-way improvements along 4th Street.

Conservation Measures

The Best Management Practices (BMPs) described below are described fully in the Biological Assessment. Portions pertinent to the analysis presented in this Biological Opinion are excerpted and summarized below.

The following conservation measures will be employed:

- All work below the mean higher high tide line will be conducted during the approved marine in-water work period (July 15 to February 15).

- A bubble curtain will be used to attenuate sound pressure generated by impact pile driving. The bubble curtain will also be used if an impact pile driver is used to install the sheet piles.

- The upgraded stormwater system will improve both the collection and discharge of chemicals into the marine environment.

- The contractor is responsible for the preparation of a spill prevention, control, and countermeasure plan that will be used for the duration of the project. The plan will identify construction planning elements, notification and reporting procedures, and will outline the response action is the event of an accidental release of chemicals.

- A spill containment kit, including oil-absorbent materials, will be on site at all times in the event of an accidental spill. All equipment, fuel hoses, and hydraulic lines will be checked daily for leaks.

- Stormwater treatment: A construction stormwater general permit will be obtained from the Department of Ecology for this project. No oil, fuel, or contaminated water will be discharged or released into marine or freshwater systems. Operations of the DCI shipyard are regulated under the NPDES permit.

- All creosote-treated material, pile stubs, and associated sediments will be disposed of in an approved upland disposal site.

- All excavation, fill, or restoration work in the upper intertidal zone will be conducted during low tide and/or in the dry.

- During removal, creosote-treated piling, stubs, and associated bottom sediments (if any) will be contained on a barge.

- Contaminated sediments will be contained on the barge and any overflow drainage will be filtered to prevent chemicals from leaching into marine waters.

- No demolition debris will be allowed to enter Guemes Channel.

- Timber pilings that break or are already broken below the waterline will be removed with a clamshell bucket. Disturbance of bottom sediments will be minimized.

- A containment boom will surround the work area to collect any floating debris. Oil-absorbent materials will be employed if a visible sheen is observed.

- Uncured concrete will not come in contact with marine water.

- The majority of coatings will be applied to steel structures prior to delivery to the site. The contractor will ensure that applications of coatings in the field do not result in discharges to the water.

- Barges will not be grounded during construction.

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). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Cavender 1978; Bond 1992; Brewin and Brewin 1997; Leary and Allendorf 1997).

Throughout its range, the bull trout is 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). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats (USFWS 2002b; USFWS 2004c; 2004d).

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 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.

Current Status and Conservation Needs

In recognition of available scientific information relating to their uniqueness and significance, five segments of the coterminous United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as interim recovery units: 1) Jarbidge River, 2) Klamath River, 3) Columbia River, 4) Coastal-Puget Sound, and 5) St. Mary-Belly River (USFWS 2002b; USFWS 2004c; 2004d). Each of these interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

A summary of the current status and conservation needs of the bull trout within these interim recovery units is provided below and a comprehensive discussion is found in the FWSs draft recovery plans for the bull trout (USFWS 2002b; USFWS 2004c; 2004d).

The conservation needs 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 at multiple scales ranging from the coterminous to local populations (a local population is a group of bull trout that spawn within a particular stream or portion of a stream system). The recovery planning process for bull trout (USFWS 2002b; USFWS 2004c; 2004d) has also identified the following conservation needs: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each interim recovery unit, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each interim recovery unit, and 4) establishment of a positive population trend. Recently, it has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit (Rieman et al. 2003).

Central to the survival and recovery of bull trout is the maintenance of viable core areas (USFWS 2002b; USFWS 2004c; 2004d). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat. Each of the interim recovery units listed above consists of one or more core areas. There are 121 core areas recognized across the coterminous range of the bull trout (USFWS 2002b; USFWS 2004c; 2004d).

Jarbidge River Interim Recovery Unit

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historic angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004d). The draft bull trout recovery plan (USFWS 2004d) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout within the core area, 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area, 3) restore and maintain suitable habitat conditions for all life history stages and forms, and 4) conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning bull trout per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004d).

Klamath River Interim Recovery Unit

This interim recovery unit currently contains three core areas and seven local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002a). Bull trout populations in this interim recovery unit face a high risk of extirpation (USFWS 2002a). The draft Klamath River bull trout recovery plan (USFWS 2002a) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the three core areas (USFWS 2002a).

Columbia River Interim Recovery Unit

The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997). This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River interim recovery unit has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. In Idaho,

for example, bull trout have been extirpated from 119 reaches in 28 streams (Idaho Department of Fish and Game 1995, in. litt.). The draft Columbia River bull trout recovery plan (USFWS 2002b) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of the bull trout within core areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good. All core areas have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: dewatering; road construction and maintenance; mining; grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species. The Service completed a core area conservation assessment for the 5-year status review and determined that, of the 97 core areas in this interim recovery unit, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, 2 are at low risk, and 2 are at unknown risk (USFWS 2005).

Coastal-Puget Sound Interim Recovery Unit

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this interim recovery unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004c). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this interim recovery unit. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this interim recovery unit. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the interim recovery unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004c) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River Interim Recovery Unit

This interim recovery unit currently contains six core areas and nine local populations (USFWS 2002c). Currently, bull trout are widely distributed in the St. Mary River drainage and occur in

nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002c). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002c). The draft St Mary Belly bull trout recovery plan (USFWS 2002c) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and forms, 4) conserve genetic diversity and provide the opportunity for genetic exchange, and 5) establish good working relations with Canadian interests because local bull trout populations in this interim recovery unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

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). 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; Goetz 1989). 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; Goetz 1989), or saltwater (anadromous form) to rear as subadults and to live as adults (Cavender 1978; McPhail and Baxter 1996; WDFW 1997). 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 (Leathe and Graham 1982; Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1996).

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

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Pratt 1985; Goetz 1989). 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). 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; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993; 1995; Rich, Jr. 1996; Watson and Hillman 1997). Watson and Hillman (1997) 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), bull trout should not be expected to simultaneously occupy all available habitats(Rieman et al. 1997).

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; Rieman et al. 1997; Gilpin 1997). 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; Spruell et al. 1999). 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, 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; Pratt 1992; Rieman and McIntyre 1993).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992; Rieman and McIntyre 1993; Baxter et al. 1997; Rieman et al. 1997). 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) (McPhail and Murray 1979; Goetz 1989; Buchanan and Gregory 1997). 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 (Fraley and Shepard 1989; Rieman and McIntyre 1993, 1995; Buchanan and Gregory 1997; Rieman et al. 1997). 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 (Bart Gamett, U. S. Forest Service. 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; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993; 1995; Rich, Jr. 1996; Watson and Hillman 1997). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). 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; Pratt 1992; Pratt and Huston 1993). Pratt (1992) 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). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992; Ratliff and Howell 1992).

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 (Frissell 1993; Goetz et al. 2004; Brenkman and Corbett 2005). 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 (Rieman and McIntyre 1993; MBTSG 1998; Frissell 1999).

In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993).

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; Goetz 1989; Donald and Alger 1993). Subadult and adult migratory bull trout feed on various fish species (Leathe and Graham 1982; Fraley and Shepard 1989; Donald and Alger 1993; Brown 1994). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001). 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*) (WDFW et al. 1997; Goetz et al. 2004).

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; Goetz et al. 2004).

Changes in Status of the Coastal-Puget Sound Interim Recovery Unit

Although the status of bull trout in Coastal-Puget Sound interim recovery unit has been improved by certain actions, it continues to be degraded by other actions, and it is likely that the overall status of the bull trout in this population segment has not improved since its listing on November 1, 1999. Improvement has occurred largely through changes in fishing regulations and habitat-restoration projects. Fishing regulations enacted in 1994 either eliminated harvest of bull trout or restricted the amount of harvest allowed, and this likely has had a positive influence on the abundance of bull trout. Improvement in habitat has occurred following restoration projects

intended to benefit either bull trout or salmon, although monitoring the effectiveness of these projects seldom occurs. On the other hand, the status of this population segment has been adversely affected by a number of Federal and non-Federal actions, some of which were addressed under section 7 of the Act. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the Act permitted the incidental take of bull trout.

Section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans (HCPs) completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP, 2) Simpson Timber HCP, 3) Tacoma Public Utilities Green River HCP, 4) Plum Creek Cascades HCP, 5) Washington State Department of Natural Resources HCP, 6) West Fork Timber HCP (Nisqually River), and 7) Forest Practices HCP. These HCPs provide landscape-scale conservation for fish, including bull trout. Many of the covered activities associated with these HCPs will contribute to conserving bull trout over the long-term; however, some covered activities will result in short-term degradation of the baseline. All HCPs permit the incidental take of bull trout.

Changes in Status of the Columbia River Interim Recovery Unit

The overall status of the Columbia River interim recovery unit has not changed appreciably since its listing on June 10, 1998. Populations of bull trout and their habitat in this area have been affected by a number of actions addressed under section 7 of the Act. Most of these actions resulted in degradation of the environmental baseline of bull trout habitat, and all permitted or analyzed the potential for incidental take of bull trout. The Plum Creek Cascades HCP, Plum Creek Native Fish HCP, and Forest Practices HCP addressed portions of the Columbia River population segment of bull trout.

Changes in Status of the Klamath River Interim Recovery Unit

Improvements in the Threemile, Sun, and Long Creek local populations have occurred through efforts to remove or reduce competition and hybridization with non-native salmonids, changes in fishing regulations, and habitat-restoration projects. Population status in the remaining local populations (Boulder-dixon, Deming, Brownsworth, and Leonard Creeks) remains relatively unchanged. Grazing within bull trout watersheds throughout the recovery unit has been curtailed. Efforts at removal of non-native species of salmonids appear to have stabilized the Threemile and positively influenced the Sun Creek local populations. The results of similar efforts in Long Creek are inconclusive. Mark and recapture studies of bull trout in Long Creek indicate a larger migratory component than previously expected.

Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of listing – habitat loss and degradation caused by reduced water quality, past and present land use management practices, water diversions, roads, and non-native fishes – continue to be threats today.

Changes in Status of the Saint Mary-Belly River Interim Recovery Unit

The overall status of bull trout in the Saint Mary-Belly River interim recovery unit has not changed appreciably since its listing on November 1, 1999. Extensive research efforts have been conducted since listing, to better quantify populations of bull trout and their movement patterns. Limited efforts in the way of active recovery actions have occurred. Habitat occurs mostly on Federal and Tribal lands (Glacier National Park and the Blackfeet Nation). Known problems due to instream flow depletion, entrainment, and fish passage barriers resulting from operations of the U.S. Bureau of Reclamation's Milk River Irrigation Project (which transfers Saint Mary River water to the Missouri River Basin) and similar projects downstream in Canada constitute the primary threats to bull trout and to date they have not been adequately addressed under section 7 of the Act. Plans to upgrade the aging irrigation delivery system are being pursued, which has potential to mitigate some of these concerns but also the potential to intensify dewatering. A major fire in August, 2006 severely burned the forested habitat in Red Eagle and Divide Creeks, potentially affecting three of nine local populations and degrading the baseline.

STATUS OF THE SPECIES – Marbled Murrelet

Legal Status

The murrelet was federally listed as a threatened species in Washington, Oregon, and northern California effective September 28, 1992 (57 FR 45328 [October 1, 1992]). The final rule designating critical habitat for the murrelet (61 FR 26256 [May 24, 1996]) became effective on June 24, 1996. The Service recently proposed a range-wide revision to the 1996 murrelet critical habitat designation (71 FR 53838 [September 12, 2006]). A final rule is expected in September 2007. The species' decline has largely been caused by extensive removal of late-successional and old-growth coastal forests which serve as nesting habitat for murrelets. Additional listing factors included high nest-site predation rates and human-induced mortality in the marine environment from gillnets and oil spills.

The Service determined that the California, Oregon, and Washington distinct population segment of the murrelet does not meet the criteria set forth in the Service's 1996 Distinct Population Segment policy (61 FR 4722 [May 24, 1996]). However, the murrelet retains its listing and protected status as a threatened species under the Act until the original 1992 listing decision is revised through formal rule-making procedures, involving public notice and comment.

Critical habitat was designated for the murrelet to addresses the objective of stabilizing the population size. To fulfill that objective, the Marbled Murrelet Recovery Plan (U.S. Fish and Wildlife Service 1997u) (Recovery Plan), focuses on protecting adequate nesting habitat by maintaining and protecting occupied habitat and minimizing the loss of unoccupied but suitable habitat (U.S. Fish and Wildlife Service 1997t:119). The Recovery Plan 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).

As explained in the Endangered Species Consultation Handbook (USFWS and NOAA 1998) and clarified by Memorandum (U.S. Fish and Wildlife Service 2006), jeopardy analyses must always consider the effect of proposed actions on the survival and recovery of the listed entity. In the case of the murrelet, the Service's jeopardy analysis will consider the effect of the action on the long-term viability of the murrelet in its listed range (Washington, Oregon, and northern California), beginning with an analysis of the action's effect on Conservation Zones 1 and 2 (described below).

Conservation Zone 1

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 extends inland 50 mi from the Puget Sound, including the north Cascade Mountains and the northern and eastern sections of the Olympic Peninsula. Forest lands in the Puget Trough have been predominately replaced by urban development and the remaining suitable habitat in Zone 1 is typically a considerable distance from the marine environment, lending special importance to nesting habitat close to Puget Sound (USFWS 1997a).

Conservation Zone 2

Conservation Zone 2 includes waters within 1.2 mi of the Pacific Ocean shoreline south of the U.S.-Canadian border off Cape Flattery and extends inland to the midpoint of the Olympic Peninsula. In southwest Washington, the Zone extends inland 50 mi from the Pacific Ocean shoreline. Most of the forest lands in the northwestern portion of Zone 2 occur on public (State, county, city, and Federal) lands, while most forest lands in the southwestern portion are privately owned. Extensive timber harvest has occurred throughout Zone 2 in the last century, but the greatest loss of suitable nest habitat is concentrated in the southwest portion of Zone 2 (U.S. Fish and Wildlife Service 1997s). Thus, murrelet conservation is largely dependent upon Federal lands in northern portion of Zone 2 and non-Federal lands in the southern portion.

Life History

Murrelets are long-lived seabirds that spend most of their life in the marine environment, but use old-growth forests for nesting. Detailed discussions of the biology and status of the murrelet are presented in the final rule listing the murrelet as threatened (57 FR 45328 [October 1, 1992]), the Recovery Plan, Ecology and Conservation of the Marbled Murrelet (Ralph et al. 1995), the final rule designating murrelet critical habitat (61 FR 26256 [May 24, 1996]), and the Evaluation Report in the 5-Year Status Review of the Marbled Murrelet in Washington, Oregon, and California (McShane et al. 2004).

Physical Description

The murrelet is taxonomically classified in the family Alcidae (alcids), a family of Pacific seabirds possessing the ability to dive using wing-propulsion. The plumage of this relatively small (9.5 in to 10 in) seabird is identical between males and females, but the plumage of adults changes during the winter and breeding periods providing some distinction between adults and juveniles. Breeding adults have light, mottled brown under-parts below sooty-brown upperparts contrasted with dark bars. Adults in winter plumage have white under-parts extending to below the nape and white scapulars with brown and grey mixed upperparts. The plumage of fledged young is similar to the adult winter plumage (U.S. Fish and Wildlife Service 1997r)

Distribution

The range of the murrelet, defined by breeding and wintering areas, extends from the northern terminus of Bristol Bay, Alaska, to the southern terminus of Monterey Bay in central California. The listed portion of the species' range extends from the Canadian border south to central California. Murrelet abundance and distribution has been significantly reduced in portions of the listed range, and the species has been extirpated from some locations. The areas of greatest concern due to small numbers and fragmented distribution include portions of central California, northwestern Oregon, and southwestern Washington (U.S. Fish and Wildlife Service 1997q).

Reproduction

Murrelet breeding is asynchronous and spread over a prolonged season. In Washington, the murrelet breeding season occurs between April 1 and September 15 (Figure 3). Egg laying and incubation occur from late April to early August and chick rearing occurs between late May and late August, with all chicks fledging by early September (in litt Hamer et al. 2003).

Murrelets lay a single-egg clutch (Nelson 1997), which may be replaced if egg failure occurs early (Tranquilla et al. 2003; McFarlane Tranquilla et al. 2003; Hebert et al. 2003) However, there is no evidence a second egg is laid after successfully fledging a first chick. Adults typically incubate for a 24-hour period, then exchange duties with their mate at dawn. Hatchlings appear to be brooded by an adult for 1 to 2 days and are then left 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). 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 1995b). Chicks fledge 27 to 40 days after hatching. The initial flight of a fledgling appears to occur at dusk and parental care is thought to cease after fledging (Nelson 1997).

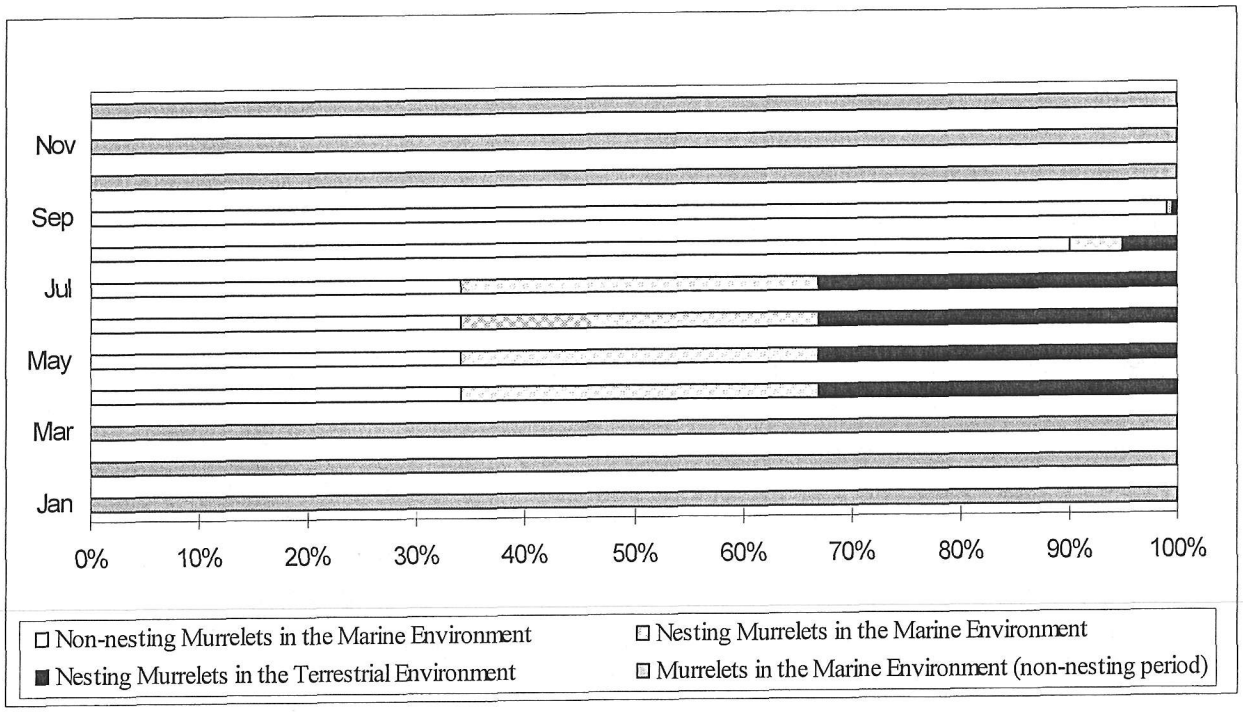

Figure 3. The seasonal changes in the relative proportion of breeding and non-breeding murrelets in the marine and terrestrial environments[1] within Washington State (Conservation Zones 1 and 2)

Vocalization

Murrelets are known to vocalize between 480 Hertz and 4.9 kilohertz and have at least 5 distinct call types (Suzanne Sanborn, pers. comm. 2005). Murrelets tend to be more vocal at sea compared to other alcids (Nelson 1997). Individuals of a pair vocalize after surfacing apart from each other, after a disturbance, and during attempts to reunite after being separated (Strachan et al. 1995).

Murrelets in the Marine Environment

Courtship, foraging, loafing, molting, and preening occur in near-shore marine waters. Beginning in early spring, courtship continues throughout summer with some observations even noted during the winter period (Speckman 1996);(Nelson 1997). Observations of courtship occurring in the winter suggest that pair bonds are maintained throughout the year (Speckman 1996; Nelson 1997). Courtship involves bill posturing, swimming together, synchronous diving, vocalizations, and chasing in flights just above the surface of the water. Copulation occurs both inland (in the trees) and at sea (Nelson 1997).

[1] Demographic estimates were derived from Peery et al. (2004) and nesting chronology was derived from Hamer and Nelson (1995) and Bradley et al. (2004) where April 1 is the beginning of the nesting season, September 15 is the end of the nesting season, and August 6 is the beginning of the late breeding season when an estimated 70 percent of the murrelet chicks have fledged.

Loafing

When murrelets are not foraging or attending a nest, they loaf on the water, which includes resting, preening, and other activities during which they appear to drift with the current, or move without direction (Strachan et al. 1995). Strachan et al. (1995) noted that vocalizations occurred during loafing periods, especially during the mid-morning and late afternoon.

Molting

Murrelets go through two molts each year. The timing of molts varies temporally throughout their range and are likely influenced by prey availability, stress, and reproductive success (Nelson 1997). Adult (after hatch-year) murrelets have two primary plumage types: alternate (breeding) plumage and basic (winter) plumage. The pre-alternate molt occurs from late February to mid-May. This is an incomplete molt during which the birds lose their body feathers but retain their ability to fly (Carter and Stein 1995; Nelson 1997). A complete pre-basic molt occurs from mid-July through December. (Carter and Stein 1995; Nelson 1997). During the pre-basic molt, murrelets lose all flight feathers somewhat synchronously and are flightless for up to two months (Nelson 1997). In Washington, there is some indication that the pre-basic molt occurs from mid-July through the end of August (Chris Thompson, WDFW, pers. comm. 2003).

Flocking

Strachan et al. (1995) defines a flock as three or more birds in close proximity which maintain that formation when moving. Various observers throughout the range of the murrelet report flocks of highly variable sizes. In the southern portion of the murrelet's range (California, Oregon, and Washington), flocks rarely contain more than 10 birds. Larger flocks usually occur during the later part of the breeding season and may contain juvenile and subadult birds (Strachan et al. 1995).

Aggregations of foraging murrelets are probably related to concentrations of prey. In Washington, murrelets are not generally found in interspecific feeding flocks (Strachan et al. 1995). Strong et al. (Strachan et al. 1995) observed that murrelets avoid large feeding flocks of other species and presumed that the small size of murrelets may make them vulnerable to kleptoparasitism or predation in mixed species flocks. Strachan et al. (1995) point out that if murrelets are foraging cooperatively, the confusion of a large flock of birds could reduce foraging efficiency.

Foraging Behavior

Murrelets forage at all times of the day, but most actively in the morning and late afternoon (Strachan et al. 1995). Murrelets typically forage in pairs, but have been observed to forage alone or in groups of three or more (Carter and Sealy 1990; Strachan et al. 1995; Speckman et al. 2003). Strachan et al. (1995) believe pairing enhances foraging success through cooperative foraging techniques. For example, pairs consistently dive together during foraging and often synchronize their dives by swimming towards each other before diving (Carter and Sealy 1990)

and resurfacing together on most dives. Strachan et al. (1995) speculate pairs may keep in visual contact underwater. Paired foraging is common throughout the year, even during the incubation period, suggesting that breeding murrelets may temporarily pair up with other foraging individuals (non-mates) (Strachan et al. 1995; Speckman et al. 2003).

Murrelets generally forage within 1.25 mi of shore (Strachan et al. 1995), but are also known to forage in freshwater lakes (Nelson 1997). Traditional feeding areas (nurseries) are used consistently on a daily and yearly basis(Carter and Sealy 1990). Activity patterns and foraging locations are influenced by biological and physical processes that concentrate prey, such as weather, climate, time of day, season, light intensity, up-wellings, tidal rips, narrow passages between islands, shallow banks, and kelp (*Nereocystis* spp.) beds (Strong et al. 1995; Ainley et al. 1995; Burger 1995; Speckman 1996; Nelson 1997).

Juveniles are found closer to shore than adults (rarely greater than 0.625 mi offshore) (Beissinger 1995) and forage without the assistance of adults (Strachan et al. 1995). Kuletz and Piatt (1999) found that in Alaska, juvenile murrelets congregated in kelp beds. Kelp beds are often with productive waters and may provide protection from avian predators (Kuletz and Piatt 1999). McAllister (in litt Strachan et al. 1995) found that juveniles were more common within 328 ft of shorelines, particularly, where bull kelp was present.

Murrelets forage most frequently in nearshore water generally less than 98 ft (30 m) deep (Strachan et al. 1995). The most common foraging depths are not known. However, murrelets are known to feed on small schools of fish within the upper 16.4 ft (5 m) of marine waters (Mahon et al. 1992). An alcid the size of a murrelet is expected to have a maximum diving depth of about 154 ft (47 m) (Mathews and Burger 1998), although the deepest record of a marbled murrelet was from one captured at 89 ft (27 m) in a gill net off of California (Carter and Erickson 1992). Jodice and Collopy (1999) reported most diving in Oregon occurred in water less than 33 feet (10 m) deep.

The duration of dives appears to depend upon age (adults vs. juveniles), water depth, and prey depth. Reported dive durations are highly variable for murrelets, ranging from 7 to 42 seconds, with an average of 14 seconds reported from observations in California (Strachan et al. 1995). Carter and Sealy (1990) reported that dive durations in British Columbia averaged 27.8 seconds and Thorensen (1989) reported dive durations in Washington ranged from 15 to 115 seconds.

Adults and subadults often move away from breeding areas prior to molting and must select areas with predictable prey resources during the flightless period (Carter and Stein 1995; Nelson 1997). During the non-breeding season, murrelets disperse and can be found farther from shore (Strachan et al. 1995). Little is known about marine-habitat preference outside of the breeding season, but use during the early spring and fall is thought to be similar to that preferred during the breeding season (Nelson 1997). During the winter there may be a general shift from exposed outer coasts into more protected waters (Nelson 1997), for example many murrelets breeding on the exposed outer coast of Vancouver Island appear to congregate in the more sheltered waters within the Puget Sound and the Strait of Georgia in fall and winter (Burger 1995). However, in many areas, murrelets remain associated with the inland nesting habitat during the winter months

(Carter and Erickson 1992) and throughout the listed range, murrelets do not appear to disperse long distances, indicating they are year-round residents (McShane et al. 2004).

Prey Species

Throughout their range, murrelets are opportunistic feeders and utilize prey of diverse sizes and species. They feed primarily on fish and invertebrates in near-shore marine waters although they have also been detected on rivers and inland lakes (Carter and Sealy 1986); 57 FR 45328 [October 1, 1992]). In general, small schooling fish and large pelagic crustaceans are the main prey items. Pacific sand lance *(Ammodytes hexapterus)*, northern anchovy *(Engraulis mordax),* immature Pacific herring *(Clupea harengus)*, capelin *(Mallotus villosus)*, and surf smelt (Osmeridae) are the most common fish species taken and are eaten year round. Squid (*Loligo* spp.), euphausiids, mysid shrimp, and large pelagic amphipods are the main invertebrate prey and are primarily eaten during the non-breeding season, thus are not a significant part of a nestling's diet.

Murrelets usually carry a single fish to their chicks and appear to select a relatively large (relative to body size), energy-rich fish such as large sand lance, immature herring, anchovy, smelt, and occasionally salmon smolts (Burkett 1995; Nelson 1997). This forces breeding adults to exercise more specific foraging strategies when feeding chicks. Freshwater prey appears to be important to some individuals during several weeks in summer and may facilitate more frequent chick feedings, especially for those that nest far inland (Hobson 1990). As a result, the distribution and abundance of prey suitable for feeding chicks may greatly influence the overall foraging behavior and location(s) during the nesting season. The availability of abundant forage fish during the nestling period may significantly affect the energy demand on adults by influencing both foraging time and number of trips inland required to feed nestlings (57 FR 45328 [October 1, 1992]).

Predators

At-sea predators include bald eagles (*Haliaeetus leucocephalus*), peregrine falcons (*Falco peregrinus*), western gulls (*Larus occidentalis*), and northern fur seals (*Callorhinus ursinus*) (McShane et al. 2004). California sea lions (*Zalophus californianus*), northern sea lions (*Eumetopias jubatus*), and large fish may occasionally prey on murrelets (Burger 2002).

Murrelets in the Terrestrial Environment

Murrelets are dependent upon old-growth forests, or forests with an older tree component, for nesting habitat (Ralph et al. 1995; Hamer and Nelson 1995; McShane et al. 2004). Sites occupied by murrelets tend to have a higher proportion of mature forest age-classes than do unoccupied sites (Raphael et al. 1995). Specifically, murrelets prefer high and broad platforms for landing and take-off, and surfaces which will support a nest cup (Hamer and Nelson 1995). The physical condition of a tree appears to be the important factor in determining the tree's suitability for nesting (Ralph et al. 1995); therefore, presence of old-growth in an area does not assure the stand contains sufficient structures (i.e. platforms) for nesting. In Washington, murrelet nests have been found in 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). Nests have been found in trees as small as 2.6 ft in diameter at breast height on limbs at least 65 ft from the ground and 0.36 ft in diameter (Hamer and Meekins 1999).

Murrelet populations may be limited by the availability of suitable nesting habitat. Although no data are available, Ralph et al. (1995) speculate the suitable nesting habitat presently available in Washington, Oregon, and California may be at or near carrying capacity based on: 1) at-sea concentrations of murrelets near suitable nesting habitat during the breeding season, 2) winter visitations to nesting sites, and 3) the limitation of nest sites available in areas with large amounts of habitat removal.

Murrelets have been observed visiting nesting habitat during non-breeding periods in Washington, Oregon, and California (Naslund 1993; Nelson 1997) which may indicate adults are defending nesting sites and/or stands (Ralph et al. 1995). Other studies provide further insight to the habitat associations of breeding murrelets, concluding that breeding murrelets displaced by the loss of nesting habitat do not pack in higher densities into remaining habitat (McShane et al. 2004). Thus, murrelets may currently be occupying nesting habitat at or near carrying capacity in highly fragmented areas and/or in areas where a significant portion of the historic nesting habitat has been removed (Ralph et al. 1995).

Unoccupied stands containing nesting structures are important to the population for displaced breeders or first-time breeding adults. Even if nesting habitat is at carrying capacity, there will be years when currently occupied stands become unoccupied as a result of temporary disappearance of inhabitants due to death or to irregular breeding (Ralph et al. 1995). Therefore, unoccupied stands will not necessarily indicate that habitat is not limiting or that these stands are not murrelet habitat (Ralph et al. 1995) and important to the species persistence.

Radar and audio-visual studies have shown murrelet habitat use is positively associated with the presence and abundance of mature and old-growth forests, large core areas of old-growth, low edge and fragmentation, proximity to the marine environment, total watershed area, and increasing forest age and height (McShane et al. 2004). In California and southern Oregon, areas with abundant numbers of murrelets were farther from roads, occurred more often in parks protected from logging, and were less likely to occupy old-growth habitat if it was isolated (more than 3 miles or 5 km) from other nesting murrelets (Meyer et al. 2002). Meyer et al. (2002) also found at least a few years passed before birds abandoned fragmented forests.

Murrelets do not form dense colonies which is atypical of most seabirds. Limited evidence suggests they may form loose colonies or clusters of nests 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). However, active nests have been seen within 328 ft (100 m) of one another in the North Cascades in Washington and within 98 ft (30 m) in Oregon (Kim Nelson, OSU, pers. comm. 2005). Estimates of murrelet nest densities vary depending upon the method of data collection. For example, nest densities estimated using radar range from 0.007 to 0.104 mean nests per acre

(0.003 to 0.042 mean nests per ha), while nest densities estimated from tree climbing efforts range from 0.27 to 3.51 mean nests per acre (0.11 to 1.42 mean nests per ha) (Nelson 2005).

There is little data available regarding murrelet nest site fidelity because of the difficulty in locating nest sites and observing banded birds attending nests. However, murrelets have been detected in the same nesting stands for many years (at least 20 years in California and 15 years in Washington), suggesting murrelets have a high fidelity to nesting areas, most likely at the watershed scale (Nelson 1997). Use of the same nest platform in successive years as well as multiple nests in the same tree have been documented, although it is not clear whether the repeated use involved the same birds (Nelson and Peck 1995; Divoky and Horton 1995; Nelson 1997; in litt Manley 2000; Hebert et al. 2003). The limited observed fidelity to the same nest depression in consecutive years appears to be lower than for other alcids, but this may be an adaptive behavior in response to high predation rates (Divoky and Horton 1995). Researchers have suggested fidelity to specific or adjacent nesting platforms may be more common in areas where predation is limited or the number of suitable nest sites are fewer because large, old-growth trees are rare ((Nelson and Peck 1995; Singer et al. 1995; Manley 1999).

Ralph et al. (1995) speculated that the fidelity to nest sites or stands by breeding murrelets may be influenced by the nesting success of previous rearing attempts. Although murrelet nesting behavior in response to failed nest attempts is unknown, nest failures could lead to prospecting for new nest sites or mates. Other alcids have shown an increased likelihood to relocate to a new nest in response to breeding failure (Divoky and Horton 1995). However, murrelets likely remain in the same watershed over time as long as stands are not significantly modified (Ralph et al. 1995).

It is unknown whether juveniles disperse from natal breeding habitat (natal dispersal) or return to their natal breeding habitat after reaching breeding age (natal philopatry). Natal dispersal distance can be expected to be as high or higher than other alcids given 1) the reduced extent of the breeding range, 2) the overlap between the wintering and breeding areas, 3) the distance individuals are known to move from breeding areas in the winter, 4) adult attendance of nesting areas during the non-breeding season where, in theory, knowledge of suitable nesting habitat is passed onto prospecting non-breeders, and 5) the 3-year to 5-year duration required for the onset of breeding age allowing non-breeding murrelets to prospect nesting and forage habitat for several years prior to reaching breeding age (Divoky and Horton 1995). Conversely, Swartzman et al. (1997 in(McShane et al. 2004) suggested juvenile dispersal is likely to be low, as it is for other alcid species. Nevertheless, the presence of unoccupied suitable nesting habitat on the landscape may be important for first-time nesters if they disperse away from their natal breeding habitat.

Murrelets generally select nests within 37 mi (60 kilometers (km)) of marine waters (Miller and Ralph 1995). However, in Washington, occupied habitat has been documented 52 mi (84 km) from the coast and murrelets have been detected up to 70 mi (113 km) from the coast in the southern Cascade Mountains (Evans Mack et al. 2003).

When tending active nests during the breeding season (and much of the non-breeding season in southern parts of the range), breeding pairs forage within commuting distance of the nest site. Daily movements between nest sites and foraging areas for breeding murrelets averaged 10 mi in Prince William Sound, Alaska (McShane et al. 2004), 24 mi in Desolation Sound, British Columbia, Canada (Hull et al. 2001), and 48 mi in southeast Alaska. In California, Hebert and Golightly (2003) found the mean extent of north-south distance traveled by breeding adults to be about 46 mi.

Murrelet nests have been located at a variety of elevations from sea level to 5,020 ft (Burger 2002). However, most nests have been found below 3,500 ft. In Conservation Zone 1, murrelets have exhibited "occupied" behaviors up to 4,400 ft elevation and have been detected in stands up to 4,900 ft in the north Cascade Mountains (Peter McBride, WDNR, pers. comm. 2005). On the Olympic Peninsula, survey efforts for nesting murrelets have encountered occupied stands up to 4,000 ft within Conservation Zone 1 and up to 3,500 ft within Conservation Zone 2. Surveys for murrelet nesting at higher elevations on the Olympic Peninsula have not been conducted. However, recent radio-telemetry work detected a murrelet nest at 3,600 ft elevation on the Olympic Peninsula in Conservation Zone 1 (Martin Raphael, USFS, pers. comm. 2005).

Population Status in the Coterminous United States

Population Abundance

Research on murrelet populations in the early 1990s estimated murrelet abundance in Washington, Oregon, and California at 18,550 to 32,000 (Ralph et al. 1995). However, consistent population survey protocols were not established for murrelets in the coterminous United States until the late 1990s following the development of the marine component of the Environmental Monitoring (EM) Program for the NWFP (Bentivoglio et al. 2002). As a consequence, sampling procedures have differed and thus the survey data collected prior to the EM Program is unsuitable for estimating population trends for the murrelet (McShane et al. 2004).

The development of the EM Program unified the various at-sea monitoring efforts within the 5 Conservation Zones encompassed by the NWFP. These efforts along with efforts in Conservation Zone 6 have resulted in annual estimates of murrelet abundance for each Conservation Zone (in litt Peery et al. 2002; Bentivoglio et al. 2002; Huff et al. 2003; WDFW (Washington Department of Fish and Wildlife) 2004), with the annual overall population estimated at 18,097 (2000), 22,200 (2001), 23,700 (2002), and 22,300 (2003).

Population Trend

Estimated population trends within each Conservation Zone or for the entire coterminous population are not yet available from the marine survey data. Trend information will eventually be provided through the analysis of marine survey data from the EM Program (Bentivoglio et al. 2002) and from survey data in Conservation Zone 6 once a sufficient number of survey years have been completed. Depending on the desired minimum power (80 or 95 percent), at least 8 to

10 years of successive surveys are required for an overall population estimate and thus detection of an annual decrease, while 7 to 16 years are required for Conservation Zones 1 and 2 (Huff et al. 2003).

In the interim, demographic modeling has aided attempts to analyze and predict population trends and extinction probabilities of murrelets. Incorporating important population parameters and species distribution data (Beissinger 1995; Beissinger and Nur 1997 in U.S. Fish and Wildlife Service 1997p; Cam et al. 2003; McShane et al. 2004), demographic models can provide useful insights into potential population responses from the exposure to environmental pressures and perturbations. However, weak assumptions or inaccurate estimates of population parameters such as survivorship rates, breeding success, and juvenile-to-adult ratios (juvenile ratios), can limit the use of models. Thus, a cautious approach is warranted when forecasting long-term population trends using demographic models.

Most of the published demographic models used to estimate murrelet population trends employ Leslie Matrix modeling(McShane et al. 2004). Two other more complex, unpublished models (Akcakaya 1997 and Swartzman et al. 1997 in McShane et al. 2004) evaluate the effect of nest habitat loss on murrelets in Conservation Zone 4(McShane et al. 2004). McShane et al. (2004) developed a stochastic Leslie Matrix model (termed "Zone Model") to project population trends in each murrelet Conservation Zone. The Zone Model was developed to integrate available demographic information for a comparative depiction of current expectations of future population trends and probability of extinction in each Conservation Zone(McShane et al. 2004). Table 1 lists rangewide murrelet demographic parameter values from four studies all using Leslie Matrix models.

Table 1. 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 *in litt.* 2003	McShane et al. 2004
Juvenile Ratios	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	(See nest success)
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 Fish and Wildlife Service 1997a

Regardless of model preference, the overall results of modeling efforts are in agreement, indicating murrelet abundance is declining (McShane et al. 2004:6-27). The rates of decline are highly sensitive to the assumed adult survival rate used for calculation (in litt Beissinger and Peery 2003). The most recent modeling effort using the "Zone Model" (McShane et al. 2004) suggests the murrelet zonal sub-populations are declining at a rate of 3.0 to 6.2 percent per year.

Estimates of breeding success are best determined from nest site data, but difficulties in finding nests has led to the use of other methods, such as juvenile ratios and radio-telemetry estimations, each of which have biases. The nest success data presented in Murrelet Table 1 under McShane et al. (2004) was derived primarily from radio telemetry studies; however the nests sampled in these studies were not representative of large areas and specifically did not include Washington or Oregon. In general, telemetry estimates are preferred over juvenile ratios for estimating breeding success due to fewer biases(McShane et al. 2004), but telemetry data are not currently available for Washington or Oregon. Therefore, it is reasonable to expect that juvenile ratios derived from at-sea survey efforts best represent murrelet reproductive success in Washington, Oregon, and California.

Beissinger and Peery (*in litt.* 2003) performed a comparative analysis using data from 24 bird species to predict the juvenile ratios for murrelets of 0.27 (confidence intervals ranged from 0.15 to 0.65). Demographic models suggest murrelet population stability requires a minimum of 0.18 to 0.28 chicks per pair per year (Beissinger and Nur 1997 in U.S. Fish and Wildlife Service 1997o). The lower confidence intervals for both the predicted juvenile ratio (0.15) and the stable population juvenile ratio (0.18) are greater than the juvenile ratios observed for any of the Conservation Zones (0.02 to 0.09 chicks per pair) (Beissinger and Nur 1997 in U.S. Fish and Wildlife Service 1997n; in litt Beissinger and Peery 2003). Therefore, the juvenile ratios observed in the Conservation Zones are lower than predicted and are too low to obtain a stable population in any Conservation Zone. This indicates murrelet populations are declining in all Conservation Zones and will continue to decline until reproductive success improves.

Demographic modeling, the observed juvenile ratios, and adult survivorship rates suggests that the number of murrelets in Washington, Oregon, and California are too low to sustain a murrelet population. The rate of decline for murrelets throughout the listed range is estimated to be between 2.0 to 15.8 percent (Beissinger and Nur 1997 in U.S. Fish and Wildlife Service 1997m);(McShane et al. 2004).

Murrelets in Washington (Conservation Zones 1 and 2)

Population estimates

Historically, murrelets in Conservation Zones 1 and 2 were "common" (Rathbun 1915 and Miller et al. 1935 in U.S. Fish and Wildlife Service 1997l), "abundant" (Edson 1908 and Rhoades 1893 in U.S. Fish and Wildlife Service 1997k), or "numerous" (Miller et al. 1935 in McShane et al. 2004). Conservation Zone 1, encompassing the Puget Sound in northwest Washington, contains one of the larger murrelet populations in the species' listed range, and supports an estimated 41 percent of the murrelets in the coterminous United States(Huff et al. 2003). The 2003 population estimate (with 95 percent confidence intervals) for Conservation Zone 1 is 8,500 (6,000 – 11,300) and Conservation Zone 2 is 3,400 (2,000 – 4,900) (Huff et al. 2003). In Conservation Zone 2, a higher density of murrelets occurs in the northern portion of the Zone (Huff et al. 2003)where the majority of available nesting habitat occurs. In Conservation Zone 1, higher densities of murrelets occur in the Straits of Juan de Fuca, the San Juan Islands, and the Hood

Canal (Huff et al. 2003), which are in proximity to nesting habitat on the Olympic Peninsula and the North Cascade Mountains.

Although population numbers in Conservation Zones 1 and 2 are likely declining, the precise rate of decline is unknown. The juvenile ratio derived from at-sea survey efforts in Conservation Zone 1 is 0.09. The juvenile ratios was not collected in Conservation Zone 2; however, the juvenile ratio for Conservation Zone 3 is 0.08. Therefore, it is reasonable to infer that the juvenile ratio for Conservation Zone 2 is likely between 0.08 and 0.09. These low juvenile ratios infer there is insufficient juvenile recruitment to sustain a murrelet population in Conservation Zones 1 and 2. Beissinger and Peery (*in litt.* 2003) estimated the rate of decline for Conservation Zone 1 to be between 2.0 to 12.6 percent and between 2.8 to 13.4 percent in Conservation Zone 3. It is likely that the rate of decline in Conservation Zone 2 is similar to that of Conservation Zones 1 and 3.

Juvenile ratios in Washington may be skewed by murrelets coming and going to British Columbia. At-sea surveys are timed to occur when the least number of murrelets from British Columbia are expected to be present. However, recent radio-telemetry information indicates: 1) murrelets nesting in British Columbia forage in Washington waters during the breeding season (Martin Raphael, USFS, pers. comm. 2005) and could be counted during at-sea surveys; and 2) adult murrelets foraging in Washington during the early breeding season moved to British Columbia in mid-June and mid-July (Bloxton and Raphael 2005) and would not have been counted during the at-sea surveys. The movements of juvenile murrelets in Washington and southern British Columbia are unclear. Therefore, until further information is obtained to define the impact of exchange of murrelets between British Columbia and Washington, we will continue to rely on the at-sea derived juvenile ratios to evaluate the population status in Conservation Zones 1 and 2.

Habitat Abundance

Estimates on the amount of available suitable nesting habitat vary as much as the methods used for estimating murrelet habitat. McShane et al. (2004) estimates murrelet habitat in Washington State at 1,022,695 acres, representing approximately 48 percent of the estimated 2,223,048 acres remaining suitable habitat in the listed range. McShane et al. (2004) caution about making direct comparisons between current and past estimates due to the evolving definition of suitable habitat and methods used to quantify habitat. As part of the ongoing pursuit to improve habitat estimates, information was collected and analyzed by the Service in 2005 resulting in an estimated 751,831 acres in Conservation Zone 1 and 585,821 acres in Conservation Zone 2 (Table 2).

Table 2. Estimated acres of suitable nesting habitat for the murrelet managed by the Federal and non-Federal land managers in Conservation Zones 1 and 2

Conservation Zone	Estimated acres of suitable murrelet habitat by land management category *				
	Federal	State	Private*	Tribal	Total
Puget Sound (Zone 1)	650,937	98,036	2,338	520	751,831
Western Washington Coast Range (Zone 2)	485,574	82,349	9,184	8,714	585,821
Total	1,136,511	180,385	11,522	9,234	1,337,652

*Estimated acres of private land represents occupied habitat. Additional suitable nesting habitat considered unoccupied by nesting murrelets is not included in this estimate.

Estimated acreages of suitable habitat on Federal lands in Table 2 are based on modeling and aerial photo interpretation and likely overestimate the actual acres of suitable murrelet habitat because 1) most acreages are based on models predicting spotted owl nesting habitat which include forested lands that do not have structures suitable for murrelet nesting, and 2) neither modeling or aerial photo interpretation can distinguish microhabitat features, such as nesting platforms or the presence of moss, that are necessary for murrelet nesting. The amount of high quality murrelet nesting habitat available in Washington, defined by the Service as large, old, contiguously forested areas not subject to human influences (e.g., timber harvest or urbanization) is expected to be a small subset of the estimated acreages in Table 2. Murrelets nesting in high-quality nesting habitat are assumed to have a higher nesting success rate than murrelets nesting in fragmented habitat near humans.

Other Recent Assessments of Murrelet Habitat in Washington

Two recent assessments of murrelet potential nesting habitat were developed for monitoring the Northwest Forest Plan (Raphael et al. 2005). This study provides a provincial-scale analysis of murrelet habitat derived from vegetation base maps, and includes estimates of habitat on State and private lands in Washington for the period of 1994 to 1996. Using vegetation data derived from satellite imagery, Raphael et al. (2005) developed two different approaches to model habitat suitability. The first model, or the Expert Judgment Model, is based on the judgment of an expert panel that used existing forest structure classification criteria (e.g., percent conifer cover, canopy structure, quadratic mean diameter, forest patch size) to classify forests into four classes of habitat suitability, with Class 1 indicating the least suitable habitat and Class 4 indicating the most highly suitable habitat. Raphael et al. (2005) found that across the murrelet range, most habitat-capable land (52 percent) is classified as Class 1 (lowest suitability) habitat and 18 percent is classified as Class 4 (highest suitability) habitat. In Washington, they found that there were approximately 954,200 acres of Class 4 habitat in between 1994 and 1996 (Table 3). However, only 60 percent of known nest sites in their study area were located in Class 4 habitat.

The second habitat model developed by Raphael et al. (2005) used the Biomapper Ecological Niche-Factor Analysis model developed by Hirzel et al. (2002). The resulting murrelet habitat suitability maps are based on both the physical and vegetative attributes adjacent to known

murrelet occupied polygons or nest locations for each Northwest Forest Plan province. The resulting raster maps are a grid of 269 ft^2-cells (25 m^2-cells) (0.15 acres per pixel). Each cell in the raster is assigned a value of 0 to 100. Values closer to 100 represent areas that match the murrelet nesting locations while values closer to 0 are likely unsuitable for nesting (Raphael et al. 2005). These maps do not provide absolute habitat estimates, but rather a range of habitat suitability values, which can be interpreted in various ways. Raphael et al. (2005) noted that the results from the Ecological Niche Factor Analysis (ENFA) are not easily compared to results from the Expert Judgment Model because it was not clear what threshold from the habitat suitability ranking to use. Raphael et al. (2005) elected to display habitat suitability scores greater than 60 (HS >60) as a "generous" portrayal of potential nesting habitat and a threshold greater than 80 (HS >80) as a more conservative estimate. In Washington, there were over 2.1 million acres of HS >60 habitat, but only 440,700 acres of HS >80 habitat (Table 3). It is important to note that HS >60 habitat map captures 82 percent of the occupied nests sites in Washington, whereas the HS >80 habitat map only captures 36 percent of the occupied nests in Washington.

Table 3. Comparison of different habitat modeling results for the Washington nearshore zone (0 to 40 mi inland or Northwest Forest Plan Murrelet Zone 1)

Murrelet Habitat Model	Habitat Acres on Federal Reserves (LSRs, Natl.Parks)	Habitat Acres on Federal, Non-Reserves (USFS Matrix)	Total Habitat Acres on Federal Lands	Total Habitat Acres on Non-Federal Lands (City, State, Private, Tribal)	Total Habitat Acres - All Ownerships	Percent of Total Habitat Acres on Non-Federal Lands	Percent of Known Murrelet Nest Sites in Study Area Occurring in this Habitat Classification
ENFA* HS >80	284,300	18,600	302,900	137,800	440,700	31%	36%
EJM* Class 4	659,200	40,700	699,900	254,300	954,200	11%	60%
EJM Class 3 and Class 4	770,600	54,700	825,300	535,200	1,360,500	16%	65%
ENFA HS >60	927,000	85,300	1,012,300	1,147,100	2,159,400	53%	82%

*ENFA = Ecological Niche Facto Analysis. EJM = Expert Judgment Model. Results were summarized directly from Tables 4 and 5 and Tables 9 and 10 in Raphael et al (2005). All habitat estimates represent 1994-1996 values.

Because the HS >60 model performed best for capturing known murrelet nest sites, Raphael et al. (2005) suggest that the ENFA HS >60 model yields a reasonable estimate of potential murrelet nesting habitat. However, we found that large areas in southwest Washington identified in the HS >60 model likely overestimates the actual suitable habitat in this landscape due to a known lack of old-forest in this landscape. Despite the uncertainties associated with interpreting the various map data developed by Raphael et al. (2005), it is apparent that there is a significant portion of suitable habitat acres located on non-Federal lands in Washington, suggesting that non-Federal lands may play a greater role in the conservation needs of the species than has previously been considered. Using the most conservative criteria developed by Raphael et al.

(2005) the amount of high-quality murrelet nesting habitat on non-Federal lands in Washington varies from 11 percent to as high as 31 percent (Table 3).

Raphael et al. (2005) note that the spatial accuracy of the map data are limited and that the habitat maps are best used for provincial-scale analysis. Due to potential errors in vegetation mapping and other potential errors, these maps are not appropriate for fine-scale project mapping. These data have not been published in their final form yet, although they have been available on the internet for public review and use since May 2005.

Conservation Zone 1

The majority of suitable murrelet habitat in Conservation Zone (Zone) 1 occurs in northwest Washington and is found on Forest Service and National Park Service lands, and to a lesser extent on State lands. The majority of the historic habitat along the eastern and southern shores of the Puget Sound has been replaced by urban development resulting in the remaining suitable habitat further inland from the marine environment (U.S. Fish and Wildlife Service 1997j).

Conservation Zone 2

Murrelet nesting habitat north of Gray's Harbor in Zone 2 occurs largely on State, Forest Service, National Park Service, and Tribal lands, and to a lesser extent, on private lands. Alternatively, the majority of habitat in the southern portion of Zone 2 occurs primarily on State lands, with a small amount on private lands.

Threats

Murrelets remain subject to a variety of anthropogenic threats within the upland and marine environment. They also face threats from low population numbers, low immigration rates, high predation rates, and disease.

Threats in the Marine Environment

Threats to murrelets in the marine environment include declines in prey availability, mortality associated with exposure to oil spills, gill net and other fisheries, contaminants suspended in marine waters, and visual or sound disturbance from recreational or commercial watercrafts (57 FR 45328 [October 1, 1992]; (Ralph et al. 1995; U.S. Fish and Wildlife Service 1997i; McShane et al. 2004).

Prey Availability

Many fish populations have been depleted due to overfishing, reduction in the amount or quality of spawning habitat, and pollution. Primary murrelet prey species have little commercial fishery value and, in general, there is little geographic overlap between murrelet distribution and areas of commercial harvest (McShane et al. 2004). However, there are several fisheries for herring and surf smelt in Puget Sound and for anchovy in Grays Harbor, Willapa Bay, and along the outer

coast (Bargmann 1998). The extent of the effects of these fisheries on murrelets is unknown, but is presumed to be minor.

In addition to fishing pressure, oceanographic variation can influence prey availability. While the effects to murrelets from events such as El Niño have not been well documented, El Niño events are thought to reduce overall prey availability and several studies have found that El Niño events can influence the behavior of murrelets (McShane et al. 2004). Even though changes in prey availability may be due to natural and cyclic oceanographic variation, these changes may exacerbate other threats to murrelets in the marine environment.

Shoreline development has affected and will continue to effect coastal processes. Shipping, bulkheads, and other shoreline developments have contributed to the reduction in eelgrass beds and other spawning and rearing areas for forage fish such as herring. Pacific herring and other small marine fish, such as sand lance and surf smelt, are important prey species. They make up a large part of the diet of murrelets.

There are 19 known stocks of Pacific herring in Puget Sound[2]. Of these populations, 15 are considered healthy or moderately healthy, three are considered depressed or critical, and the status of the remaining stock is unknown. According to WDNR (2000:99), herring spawning stocks decreased from over 20,000 tons in the 1970s to less than 10,000 tons in recent years. Cherry Point, within the Strait of Georgia, supports the largest herring stock in Washington and has experienced a precipitous decline. The decline of this stock may be affecting the forage base for murrelets in this region of Puget Sound. There is a moderate likelihood that organic contaminants are incrementally affecting this stock. Past research has shown that exposure to contamination reduces reproductive capability, growth rates, and resistance to disease, and may lead to lower survival for salmon (WDNR 2000).

Following the Exxon-Valdez oil spill, a study was initiated in Prince William Sound that included a comparison of oiled areas with unoiled areas and also compared pre-spill populations with post-spill populations (Klosiewski and Laing 1994). That study indicated that murrelets decreased in both oiled and unoiled areas. Total population estimates declined from 304,400 in 1972-73 to 98,400 in 1989-1991. In the conclusion of that study, which also addressed many other bird species, it was noted that a number of bird species feeding on small fish have decreased in the past several decades, while bird species feeding on benthic organisms did not decrease similarly.

Oil Spills

Murrelet mortality from oil pollution is a conservation issue in Washington (U.S. Fish and Wildlife Service 1997h). Most oil spills and chronic oil pollution that can affect murrelets occur in areas of high shipping traffic, such as the Strait of Juan de Fuca and Puget Sound. There have been at least 47 oil spills of 10,000 gal or more in Washington since 1964 (WDOE 2004).

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[2] A spawning ground at Wollochet Bay was not included in surveys prior to 2002. In previous publications, the number of stocks of Pacific herring has been reported at 18 (PSAT 2005).

However, the number of oil spills has generally declined since passage of the U.S. Oil Pollution Act in 1990. The estimated annual mortality of murrelets from oil spills in Washington has decreased from 3 to 41 birds per year (between 1977 and 1992) to 1 to 2 birds per year (between 1993 and 2003) (McShane et al. 2004).

Since the murrelet was listed, the amount of oil tanker and shipping traffic has continued to increase (U.S. Fish and Wildlife Service 1997g; Burger 2002). Large commercial ships, including oil tankers, cargo ships, fish processing ships, and cruise ships, enter Washington waters more than 7,000 times each year, bound for ports in Puget Sound, British Columbia, Grays Harbor, and the Columbia River (WDOE 2004). Additionally, 4,500 tank-barge transits, 160,000 ferry transits, and military vessel traffic occur in these same waters each year (WDOE 2004). Individually these vessels may carry up to 33 M gal of crude oil or refined petroleum products, but collectively, they carry about 15.1 B gal across Puget Sound waters each year (WDOE 2004). These numbers are expected to increase as the human population and commerce continues to grow. Currently, there are State and Federal requirements for tug escorts of laden oil tankers transiting the waters of Puget Sound east of Dungeness Spit. However, the Federal requirements do not apply to double-hulled tankers and will no longer be in effect once the single-hull tanker phase-out is complete (WDOE 2005). Washington State is considering revising their tug escort requirements (WDOE 2005); however, the current tug escort requirements remain in place until the Washington State Legislature makes a change.

The U.S. Coast Guard rated the Dungeness area in the Strait of Juan de Fuca as being in the top five high-risk areas of the United States for being impacted by oil spills (U.S. Fish and Wildlife Service 2005). Therefore, even though the threat from oil spills appears to have been reduced since the murrelet was listed, the risk of catastrophic oil spill remains, and could severely impact adult and/or juvenile murrelets in Conservation Zones 1 and 2.

Gillnets

Murrelet mortality from gillnet fishing has been considered a conservation issue in Washington (U.S. Fish and Wildlife Service 1997f; Melvin et al. 1999). Murrelets can also be killed by hooking with fishing lures and entanglement with fishing lines (Carter et al. 1995). There is little information available on murrelet mortality from net fishing prior to the 1990s, although it was known to occur (Carter et al. 1995). In the mid 1990s, a series of fisheries restrictions and changes were implemented to address mortality of all species of seabirds, resulting in a lower mortality rate of murrelets (McShane et al. 2004). Fishing effort has also decreased since the 1980s because of lower catches, fewer fishing vessels, and greater restrictions (McShane et al. 2004), although a regrowth in gill net fishing is likely to occur if salmon stocks increase. In most areas, the threat from gill net fishing has been reduced or eliminated since 1992, but threats to adult and juvenile murrelets are still present in Washington nearshore zones due to gill net mortality (McShane et al. 2004).

Marine Contaminants

The primary consequence from the exposure of murrelets to contaminants is reproductive impairment. Reproduction can be impacted by food web bioaccumulation of organochlorine pollutants and heavy metals discharged into marine areas where murrelets feed and prey species concentrate (Fry 1995). However, murrelet exposure is likely a rare event because murrelets have widely dispersed foraging areas and they feed extensively on transient juvenile and subadult midwater fish species that are expected to have low pollutant loads (McShane et al. 2004). The greatest exposure risk to murrelets may occur at regular feeding areas near major pollutant sources, such as those found in Puget Sound (McShane et al. 2004).

Disturbance

In coastal and offshore marine environments, vehicular disturbance (e.g., boats, airplanes, personal watercraft) is known to elicit behavioral responses in murrelets of all age classes (Kuletz 1996; Speckman 1996; Nelson 1997). Aircraft flying at low altitudes and boating activity, in particular motorized watercraft, are known to cause murrelets to dive and are thought to especially affect adults holding fish (Nelson 1997). It is unclear to what extent this kind of disturbance affects the distribution and movements of murrelets. However, it is unlikely this type of disturbance has decreased since 1992 because the shipping traffic and recreational boat use in the Puget Sound and Strait of Juan de Fuca has continued to increase.

Marine projects that include seismic exploration, pile driving, detonation of explosives and other activities that generate percussive sounds can expose murrelets to elevated underwater sound pressure levels (SPLs). High underwater SPLs can have adverse physiological and neurological effects on a wide variety of vertebrate species (Yelverton et al. 1973; Yelverton and Richmond 1981; Stevens et al. 1999; Fothergill et al. 2001; Cudahy and Ellison 2002) U.S. Department of the Navy 2002 (Popper 2003). High underwater SPLs are known to injure and/or kill fish by causing barotraumas (pathologies associated with high sound levels including hemorrhage and rupture of internal organs), as well as causing temporary stunning and alterations in behavior (Turnpenny and Nedwell 1994; Turnpenny et al. 1994; Popper 2003; Hastings and Popper 2005). During monitoring of seabird response to pile driving in Hood Canal, Washington, a pigeon guillemot (*Cepphus columba*) was observed having difficulty getting airborne after being exposed to underwater sound from impact pile driving (Entranco, Inc. and Hamer Environmental, L.P. 2005). In controlled experiments using underwater explosives, rapid change in SPLs caused internal hemorrhaging and mortality in submerged mallard ducks (*Anas platyrhnchos*) (Yelverton et al. 1973). Risk of injury appears related to the effect of rapid pressure changes, especially on gas filled spaces in the bodies of exposed organisms (Turnpenny et al. 1994). In studies on ducks (*Anas spp.*) and a variety of mammals, all species exposed to underwater blasts had injuries to gas filled organs including eardrums (Yelverton and Richmond 1981). These studies indicate that similar effects can be expected across taxonomical species groups.

Physical injury may not result in immediate mortality. If an animal is injured, death may occur several hours or days later, or injuries may be sublethal. Sublethal injuries can interfere with the ability of an organism to carry out essential life functions such as feeding and predator

avoidance. Diving birds are able to detect and alter their behavior based on sound in the underwater environment (Ross et al. 2001) and elevated underwater SPLs may cause murrelets to alter normal behaviors, such as foraging. Disturbance related to elevated underwater SPLs may reduce foraging efficiency resulting in increased energetic costs to all murrelet age classes in the marine environment and may result in fewer deliveries or lower quality food being delivered to nestlings.

Threats in the Terrestrial Environment

Habitat

Extensive harvest of late-successional and old-growth forest was the primary reason for listing the murrelet as threatened. Due primarily to extensive timber cutting over the past 150 years, at least 82 percent of the old-growth forests existing in western Washington and Oregon prior to the 1840s have been harvested (Teensma et al. 1991; Booth 1991; Ripple 1994; Perry 1995). About 10 percent of pre-settlement old-growth forests remain in western Washington (Norse 1990)(Booth 1991). Although the Northwest Forest Plan has reduced the rate of habitat loss on Federal lands, the threat of continued loss of suitable nesting habitat remains on Federal and non-Federal lands through timber harvest and natural events such as wildfire, insect outbreaks, and windthrow.

Natural disturbance has the potential to affect the amount and quality of murrelet nesting habitat. Wildfire and windthrow result in immediate loss of habitat and can also influence the quality of adjacent habitat. Global warming, combined with long-term fire suppression on Federal lands, may result in higher incidences of stand-replacing fires in the future (McShane et al. 2004). As forest fragmentation increases, the threat of habitat loss due to windthrow is likely to increase. In addition, insects and disease can kill complete stands of habitat and can contribute to hazardous forest fire conditions.

Between 1992 and 2003, the loss of suitable murrelet habitat totaled 22,398 acres in Washington, Oregon, and California combined, of which 5,364 acres resulted from timber harvest and 17,034 acres resulted from natural events (McShane et al. 2004). The data presented by McShane represented losses primarily on Federal lands, and did not include data for most private lands within the murrelets' range. Habitat loss and fragmentation is expected to continue in the near future, but at an uncertain rate (McShane et al. 2004). Raphael et al. (2005) recently completed a change analysis for marbled murrelet habitat on both Federal and non-Federal lands for the period from 1992 to 2003, based on stand disturbance map data developed by Healey et al. (2003). Raphael et al. (2005) estimated that habitat loss ranging from 60,000 acres up to 278,000 acres has occurred across the listed range of the species, with approximately 10 percent of habitat loss occurring on Federal lands, and 90 percent occurring on non-Federal lands. The variation in the acreage estimates provided by Raphael et al. (2005) are dependant upon the habitat model used (Table 3) to evaluate habitat change over time.

Gains in suitable nesting habitat are expected to occur on Federal lands over the next 40 to 50 years, but due to the extensive historic habitat loss and the slow replacement rate of murrelets

and their habitat, the species is potentially facing a severe reduction in numbers in the coming 20 to 100 years (USFWS and USBLM 1994b; Beissinger 2002). In addition to direct habitat removal, forest management practices can fragment murrelet habitat; this reduces the amount and heterogeneous nature of the habitat, reduces the forest patch sizes, reduces the amount of interior or core habitat, increases the amount of forest edge, isolates remaining habitat patches, and creates "sink" habitats (McShane et al. 2004). There are no estimates available for the amount of suitable habitat that has been fragmented or degraded since 1992. However, the ecological consequences of these habitat changes to murrelets can include effects on population viability and size, local or regional extinctions, displacement, fewer nesting attempts, failure to breed, reduced fecundity, reduced nest abundance, lower nest success, increased predation and parasitism rates, crowding in remaining patches, and reductions in adult survival (Raphael et al. 2002).

Predation

Predation is expected to be the principal factor limiting murrelet reproductive success and nest site selection (Ralph et al. 1995; Nelson and Hamer 1995a; Nelson and Hamer 1995d). Murrelets are believed to be highly vulnerable to nest predation compared to other alcids and forest nesting birds Nelson and (Nelson and Hamer 1995a; Nelson and Hamer 1995d; U.S. Fish and Wildlife Service 1997e). Murrelets have no protection at nest sites other than the ability to remain hidden. Nelson and Hamer (1995b) hypothesized that small increases in murrelet predation will have deleterious effects on murrelet population viability due to their low reproductive rate (one egg clutches).

Known predators of adult murrelets in the forest environment include the peregrine falcon (*Falco peregrinus*), sharp-shinned hawk (*Accipiter striatus*), common raven (*Corvus corax*), northern goshawk (*Accipiter gentilis*), and bald eagle (*Haliaeetus leucocephalus*). Common ravens and Stellar's jays (*Cyanocitta stelleri*) are known to take both eggs and chicks at the nest, while sharp-shinned hawks have been found to take chicks. Common ravens account for the majority of egg depredation, as they appear to be the only predator capable of flushing incubating or brooding adults from a nest (Nelson and Hamer 1995a; Nelson and Hamer 1995d). Suspected nest predators include great horned owls (*Bubo virginianus*), barred owls (*Strix varia*), Cooper's hawks (*Accipiter cooperi*), northwestern crows (*Corvus caurinus*), American crows (*Corvus brachyrhynchos*), and gray jays (*Perisoreus canadensis*) (Nelson and Hamer 1995c; Nelson 1997; Manley 1999). Predation by squirrels and mice has been documented at artificial nests and these animals cannot be discounted as potential predators on eggs and chicks ((Luginbuhl et al. 2001; Raphael et al. 2002; Bradley and Marzluff 2003).

Losses of eggs and chicks to avian predators have been determined to be the most important cause of nest failure (Nelson and Hamer 1995a; McShane et al. 2004). The risk of predation by avian predators appears to be highest in complex structured landscapes in proximity to edges and human activity, where many of the corvid (e.g., crows, ravens) species are in high abundance. Predation rates are influenced mainly by habitat stand size, habitat quality, nest placement (on the edge of a stand versus the interior of a stand), and proximity of the stand to human activity centers. The quality of murrelet nest habitat decreases in smaller stands because forest edge

increases in relation to the amount of interior forest, while forest stands near human activity centers (less than 0.62 mi or 1 km), regardless of size, are often exposed to a higher density of corvids due to their attraction to human food sources (Marzluff et al. 2000). The loss of nest contents to avian predators increases with habitat fragmentation and an increase in the ratio of forest edge to interior habitat (Nelson and Hamer 1995a; McShane et al. 2004). For example, Nelson and Hamer (1995b) found successful nests were farther from edges (greater than 55 m) and were better concealed than unsuccessful nests.

The abundance of several corvid species has increased dramatically in western North America as a result of forest fragmentation, increased agriculture, and urbanization (McShane et al. 2004). It is reasonable to infer that as predator abundance has increased, predation on murrelet chicks and eggs has also increased, and murrelet reproductive success has decreased. It is also reasonable to assume that this trend will not be interrupted or reversed in the near future, as forest fragmentation, agriculture, and urbanization continue to occur.

Other Threats

Murrelets are subject to additional threats from diseases, genetics, low population numbers, and low immigration rates. To date, inbreeding (mating between close genetic relatives) and/or hybridizing (breeding with a different species or subspecies) have not been identified as threats to murrelet populations. However, as abundance declines, a corresponding decrease in the resilience of the population to disease, inbreeding or hybridization, and other perturbations may occur. Additionally, murrelets are considered to have low recolonization potential because their low immigration rate makes the species slow to recover from local disturbances (McShane et al. 2004).

The emergence of fungal, parasitic, bacterial, and viral diseases has affected populations of seabirds in recent years. West Nile virus disease has been reported in California which is known to be lethal to seabirds. While the amount of negative impact this disease may bring is unknown, researchers agree that it is only a matter of time before West Nile virus reaches the Washington seabird population. Effects for murrelets from West Nile virus and other diseases are expected to increase in the near future due to an accumulation of stressors such as oceanic temperature changes, overfishing, and habitat loss (McShane et al. 2004).

Murrelets may be sensitive to human-caused disturbance due to their secretive nature and their vulnerability to predation. There are little data concerning the murrelet's vulnerability to disturbance effects, except anecdotal researcher observations that indicate murrelets typically exhibit a limited, temporary behavioral response (if any) to noise disturbance at nest sites and are able to adapt to auditory stimuli (Long and Ralph 1998; Golightly et al. 2002; Singer et al. 1995 in McShane et al. 2004). In general, responses to auditory stimuli at nests sites have been modifications of posture and on-nest behaviors (Long and Ralph 1998). While the unique breeding biology of the murrelet is not conducive to comparison of the reproductive success of other species, studies on other alcid and seabird species have revealed detrimental effects of disturbance to breeding success and the maintenance of viable populations (Cairns 1980; Pierce and Simons 1986; Piatt et al. 1990; Beale and Monaghan 2004).

Research on a variety of other species, including other seabirds, indicate an animal's response to disturbance follows the same pattern as its response to encountering predators, and anti-predator behavior has a cost to other fitness enhancing activities, such as feeding and parental care (Frid and Dill 2002). Some authors indicate disturbance stimuli can directly affect the behavior of individuals and indirectly affect fitness and population dynamics through increased energetic costs (Carney and Sydeman 1999; Frid and Dill 2002). Responses by murrelet adults and chicks to calls from corvids and other potential predators include no response, alert posturing, aggressive attack, and temporarily leaving a nest (adults only) (McShane et al. 2004). However, the most typical behavior of chicks and adults in response to the presence of a potential predator is to flatten against a tree branch and remain motionless (Nelson and Hamer 1995a; McShane et al. 2004). Therefore, researcher's anecdotal observations of little or no physical response by murrelets are consistent with the behavior they will exhibit in response to a predator. In addition, there may have been physiological responses researchers cannot account for with visual observations. Corticosterone studies have not been conducted on murrelets, but studies on other avian species indicate chronic high levels of this stress hormone may have negative consequences on reproduction or physical condition (Wasser et al. 1997; Marra and Holberton 1998 in McShane et al. 2004).

Although detecting effects of sub-lethal sound disturbance at the population level is hindered by the breeding biology of the murrelet, the effect of sound disturbance on murrelet fitness and reproductive success should not be completely discounted (McShane et al. 2004). In recently completed analyses, the Service concluded the potential for injury associated with disturbance (visual and sound) to murrelets in the terrestrial environment includes flushing from the nest, aborted feeding, and postponed feedings (USFWS 2003a). These responses by individual murrelets to disturbance stimuli can reduce productivity of the nesting pair, as well as the entire population (U.S. Fish and Wildlife Service 1997d).

Conservation Needs

The Recovery Plan outlines the conservation strategy for the species. In the short-term, specific actions necessary to stabilize the population include maintaining occupied habitat, 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.

Long-term conservation needs 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. The Service estimates recovery of the murrelet will require at least 50 years (U.S. Fish and Wildlife Service 1997c).

The Recovery Plan states that four of the six Conservation Zones (Zones) must be functional in order to effectively recover the murrelet in the short- and long-term; that is, to maintain viable populations that are well-distributed. However, based on the new population estimates, it appears only three of the Zones contain relatively robust numbers of murrelets (Zones 1, 3, and

4). Zones 1 and 4 contain the largest number of murrelets compared to the other four Zones. This alone would seem to indicate a better condition there, but areas of concern remain. For example, the population in Zone 4 was impacted when oil spills killed an estimated 10 percent of the population (Bentivoglio et al. 2002; Ford et al. 2002), small oil spills continue to occur in Zone 1, and the juvenile ratios in both of these Zones continue to be too low to establish stable or increasing populations (in litt Beissinger and Peery 2003).

Murrelets in Zones 3, 5, and 6 have suffered variously from past oil spills which killed a large number of murrelets (Zone 3) (Ford et al. 2001), extremely small population sizes (Zones 5 and 6), and alarmingly low reproductive rates (Zone 6) (in litt Peery et al. 2002). These factors have brought the status of the species to a point where recovery in Zones 5 and 6 may be precluded (Beissinger 2002). The poor status of murrelet populations in the southern Zones emphasizes the importance of supporting murrelet populations in Zones 1 and 2 in order to preserve the opportunity to achieve murrelet recovery objectives.

Conservation Strategy

Marine Environment

Protection of marine habitat is also a component of the recovery strategy. The main threat to murrelets in the marine environment is the loss of individuals through death or injury, generally associated with oil spills and gill-net entanglements. The recovery strategy recommends managing all waters within 1.2 mi of shore within the Puget Sound and Strait of Juan de Fuca, and along the Pacific Coast from Cape Flattery to Willapa Bay in such a way as to reduce or eliminate murrelet mortality (U.S. Fish and Wildlife Service 1997b). Management strategies could include exclusion of vessels, stricter hull requirements, exclusion of net fisheries, or modification of fishing gear.

In Washington State, the Washington Fish and Game Commission requires the use of alternative gear (i.e., visual alerts within the upper 7 ft of a multifilament net), prohibits nocturnal and dawn fishing for all non-treaty gill-net fisheries, and closes areas to gill-net fishing in order to reduce by-catch of murrelets. The Olympic Coast National Marine Sanctuary was established in 1994 along the outer Washington coast from Cape Flattery south to approximately the Copalis River and extending between 25 mi and 40 mi offshore. Oil exploration and development are prohibited within this Sanctuary (National Marine Fisheries Service 1993).

Terrestrial Habitat Management

The loss of nesting habitat (old-growth/mature forest) has generally been identified as the primary cause of the murrelet population decline and disappearance across portions of its range (Ralph et al. 1995). Logging, urbanization, and agricultural development have all contributed to the loss of habitat, especially at lower elevations.

The recovery strategy for the murrelet is contained within the Marbled Murrelet Recovery Plan (Recovery Plan) (U.S. Fish and Wildlife Service 1997a) relies heavily on the Northwest Forest

Plan (NWFP) to achieve recovery on Federal lands in Washington, Oregon, and California. However, the Recovery Plan also addresses the role of non-Federal lands in recovery, including Habitat Conservation Plans, State forest practices, and lands owned by Native American Tribes. The importance of non-Federal lands in the survival and recovery of murrelets is particularly high in Conservation Zones, where Federal lands, and privately held conservation lands (e.g., The Nature Conservancy Teal Slough, Ellsworth, Washington), within 50 mi of the coastline are sparse, such as the southern half of Conservation Zone 2.

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 mi of the coast, and 5) habitat within occupied murrelet sites on private lands (U.S. Fish and Wildlife Service 1997v).

Northwest Forest Plan

When the U.S. Forest Service (USFS) and Bureau of Land Management incorporated the NWFP as the management framework for public lands, a long-term habitat management strategy for murrelets (USFS and USBLM 1994; USFWS and USBLM 1994a) was established. The NWFP instituted pre-project surveys of murrelet habitat in areas planned for timber harvest and the protection of existing habitat at sites determined through surveys to be occupied by murrelets.

In the short-term, all known-occupied sites of murrelets occurring on USFS or Bureau of Land Management lands under the NWFP are to be managed as Late Successional Reserves (LSRs). In the long-term, unsuitable or marginally suitable habitat occurring in LSRs will be managed, overall, to develop late-successional forest conditions, thereby providing a larger long-term habitat base into which murrelets may eventually expand. Thus, the NWFP approach offers both short-term and long-term benefits to the murrelet.

Over 80 percent of murrelet habitat on Federal lands in Washington occurs within land management allocations that protect the habitat from removal or significant degradation. Scientists predicted implementation of the NWFP would result in an 80 percent likelihood of achieving a well-distributed murrelet population on Federal lands over the next 100 years (U.S. Forest Service and U.S. Fish and Wildlife Service 1994b). Although the NWFP offers protection of known-occupied murrelet sites, concerns over the lingering effects of the historic widespread removal of suitable habitat will remain until the habitat recovers to late-successional characteristics. Habitat recovery will require over 100 years in many LSRs.

Habitat Conservation Plans

Four Habitat Conservation Plans (HCP) addressing murrelets in Washington have been completed for private/corporate forest land managers within the range of the murrelet: West Fork Timber Corporation (Murray Pacific Corporation 1993; Murray Pacific Corporation 1995; USFWS 1995) (Mineral Tree Farm HCP); Plum Creek Timber Company (Plum Creek Timber

Company,L.P. 1996; USFWS 1996a; Plum Creek Timber Company,L.P. 1999; USFWS 1999) (Cascades HCP; I-90 HCP); Port Blakely Tree Farms, L.P. (Port Blakely Tree Farms,L.P. 1996; USFWS 1996b) (R.B. Eddy Tree Farm HCP); and Simpson Timber Company (Simpson Timber Company 2000; USFWS 2000b) (Olympic Tree Farm HCP). Habitat Conservation Plans have also been completed for two municipal watersheds, City of Tacoma (USFWS 2001; Tacoma Public Utilities 2001) (Green River HCP) and City of Seattle (USFWS 2000a; City of Seattle 2001) (Cedar River HCP), and the Washington Department of Natural Resources (U.S. Fish and Wildlife Service 1997w) (WDNR HCP). The HCPs which address murrelets cover approximately 500,000 acres of non-Federal (private/corporate) lands, over 100,000 acres of municipal watershed, and over 1.6 million acres of State-managed lands. However, only a portion of these lands contain suitable murrelet habitat.

The WDNR HCP addresses murrelets in Conservation Zones 1 and 2. All of the others address murrelets in Conservation Zone 1. Most of the murrelet HCPs in Washington employ a consistent approach for murrelets by requiring the majority of habitat to be surveyed prior to timber management. Only poor-quality marginal habitat (with a low likelihood of occupancy) is released for harvest without survey. All known occupied habitat is protected to varying degrees, but a "safe-harbor-like" approach is used to address stands which may be retained as, or develop into, suitable habitat and become occupied in the future. This approach would allow future harvest of habitat which is not currently nesting habitat.

Washington State Forest Practices Regulations

Under Washington Forest Practices Rules, which apply to all non-Federal lands not covered by an HCP (WAC 222-12-041) (WFPB 2005), surveys for murrelets are required prior to the harvest of suitable nesting habitat. These criteria vary depending on the location of the stand. For stands found to be occupied or known to be previously occupied, the WDNR makes a decision to issue the permit based upon a significance determination. If a determination of significance is made, preparation of a State Environmental Policy Act Environmental Impact Statement is required prior to proceeding. If a determination of non-significance or mitigated determination of non-significance is reached, the action can proceed without further environmental assessment. (A more detailed discussion of the Washington Forest Practices regulations is provided in the murrelet Environmental Baseline).

Tribal Management

The management strategy of the Bureau of Indian Affairs for the murrelet focuses on working with Tribal governments on a government-to-government basis to develop management strategies for reservation lands and trust resources. The Bureau of Indian Affairs' management strategy typically focus on avoiding harm to murrelets when feasible, to facilitate the trust responsibilities of the United States. However, other factors must be considered. Strategies must foster Tribal self-determination, and must balance the needs of the species and the environmental, economic, and other objectives of Indian Tribes within the range of the murrelet (in litt Renwald 1993). For example, one of the Bureau of Indian Affairs' main goals for

murrelet protection includes assisting Native American Tribes in managing habitat consistent with tribal priorities, reserved Indian rights, and legislative mandates.

Summary

Demographic modeling results indicate murrelet populations are declining within each Conservation Zone and throughout the listed range. The juvenile to adult ratios observed at sea in the Conservation Zones are too low to obtain a stable population in any Conservation Zone, which indicates murrelet abundance in all Conservation Zones will continue to decline until reproductive success improves. In other words, there is insufficient recruitment of juveniles to sustain a murrelet population in the listed range of the species.

Some of the threats to the murrelet population may have been reduced as a result of the species' listing under the Act, such as the passage of the Oil Pollution Act and implementation of the NWFP. However, no threats have been reversed since listing and in some areas threats, such as predation and West Nile Virus, may be increasing or emerging. 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 little resilience to deleterious population-level effects and are at high risk of extirpation.

Considering the life history characteristics of the murrelet, with the aggregate effects of inland habitat loss and fragmentation and at-sea mortality, the species' capability to recover from lethal perturbations at the population or metapopulation (Conservation Zone) scale is extremely low. The low observed reproductive rates make the species highly susceptible to local extirpations when exposed to repeated perturbations at a frequency which exceeds the species' loss-replacement rate. Also troublesome is the ineffectiveness of recovery efforts at reversing the ongoing lethal consequences in all demographic classes from natural and anthropogenic sources. Despite the relatively long potential life span of adult murrelets, the annual metapopulation replacement rates needed for long-term metapopulation maintenance and stability is currently well below the annual rate of individuals being removed from each metapopulation. As a result, murrelet metapopulations are currently not self-sustaining or self-regulating.

Accordingly, the Service concludes the current environmental conditions for murrelets in the coterminous United States appear to be insufficient to support the long-term conservation needs of the species. Although information is not sufficient to determine whether murrelets are nesting at or near the carrying capacity in the remaining nest habitat, 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.

ENVIRONMENTAL BASELINE (in the action area)

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

Description of the Action Area

The action area for this project includes the aquatic area affected by the extent of underwater sound generated during pile driving and the area where turbidity levels will be elevated from dredging operations. Estimating the propagation of a sound wave through water is extremely complicated. The study of sound propagation has been given considerable attention (Richardson et al. 1995; Gausland 1998) and sophisticated models have been developed. Most models require site specific data and it is often not feasible to obtain the appropriate data prior to a project's implementation. In the absence of site specific data, it is possible to make predictions based on physical principles and field measurements.

Pile driving is the primary activity that will affect listed species. Detectable sound associated with impact hammers on 24- and 30-in piles have been shown to extend for miles. In the case of this project, the Service expects that underwater sound produced during construction will extend up to 3 miles across Guemes Channel to the shorelines of Guemes and Cypress Islands. As such, the aquatic action area is defined by adjacent islands (Figure 4).

Figure 4: Action Area

Baseline Conditions in the Action Area

The Port of Anacortes is located on the northern tip of the Fidalgo Peninsula and borders Guemes Channel. The upland area surrounding the Port includes residential and commercial development interspersed with mixed conifer/deciduous forest. The marine environment supports communities of aquatic vegetation and marine animals typically found in Puget Sound and the Georgia Straits.

The upland areas in the immediate vicinity of the port include industrial buildings and warehouses, the DCI shipyard, commercial marine facilities, parking lots, and heavy equipment storage areas (Figure 5). The waterfront along the Port is dominated by piers and commercial vessel moorage. The industrial waterfront extends for about half a mile and then transitions to residential housing. Development extends to the waterfront and includes areas of armoring and natural shoreline. Guemes Channel and Rosario Strait are characterized by low density

development. Guemes Island lies across the channel from the Port and supports approximately 500 year-round residents.

Figure 5: Port of Anacortes and adjacent residential areas

Shipyards have been operating on various portions of the DCI shipyard site for over 70 years. When it was constructed in 1926, Pier 1 included wooden piles, wooden decks, and a transit shed (Grette Associates 2005a). The existing DCI shipyard facilities include a 350-foot building grid, to repair piers, two marine railways, a 5,000-ton synchrolift (marine elevator used for lifting ships out of, or into, the water), and a 314-foot long drydock with 7,000-ton capacity moorage. The site also has various support structures, including warehouses, manufacturing shops, and storage containers (Grette Associates 2005a). Services at the DCI shipyard include ship repairs, modifications, and new vessel construction. Some of the regular activities that are conducted on site include welding, sandblasting, painting, repair or construction of hydraulic, electrical, refrigeration, and propulsion systems. Vessels are transported via rail for service in the upland area.

Skagit County is primarily rural and has a population of approximately 100,000 people. In 1999, the population of Anacortes was estimated at 15,000 (Port of Anacortes 2005). Fishing and wood products industries dominated the early economic development of Anacortes. Two major seafood processors still operate in Anacortes but only one log export yard remains (City of Anacortes 2007). Beginning in the 1950s, economic forces shifted towards refineries built by Shell and Texaco at nearby March Point. In the 1960s, housing developments grew and the area attracted retirees. Tourism increased and marinas replaced former mills and canneries (City of Anacortes 2007).

In Anacortes there is a concentration of industrial and commercial uses along the shoreline including Guemes Channel. The zoning classification transitions from commercial marine at the ferry terminal to light manufacturing along Guemes Channel at the Port (Figure 6).

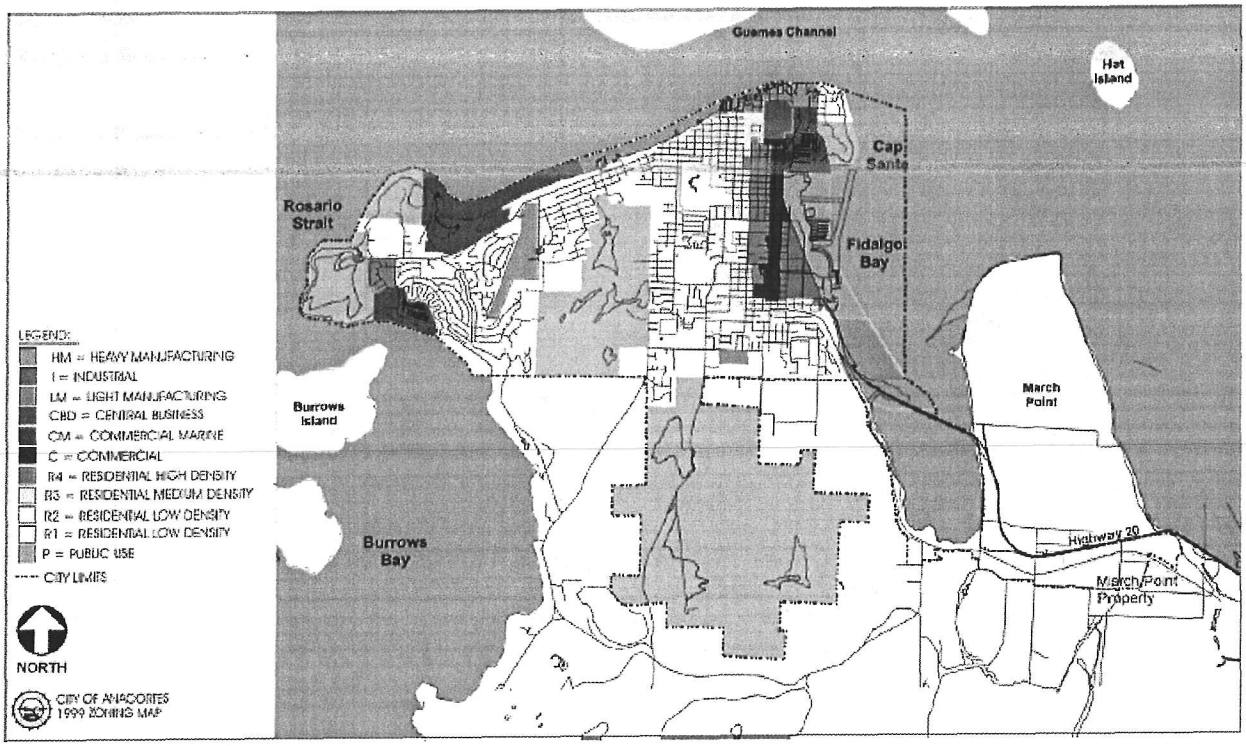

Figure 6: Current zoning in project vicinity (Port of Anacortes 2005)

The Port District of the Port of Anacortes encompasses approximately 110 square miles. The Port of Anacortes is the primary public cargo port in Skagit County. The Port's primary operations include handling cargo such as petroleum coke and logs, operation of a 1,000 boat marina on Fidalgo Bay, and managing the Anacortes Airport (Port of Anacortes 2005).

Water Quality

The waters of Guemes Channel are classified by the Washington Department of Ecology (WDOE) as "excellent" per WAC 173-201A-210. "Excellent" is defined as: Excellent quality salmonid and other fish migration, rearing, and spawning; clam, oyster, and mussel rearing and spawning; crustaceans and other shellfish (crabs, shrimp, crayfish, scallops, etc.) rearing and spawning. However, Guemes Channel is listed on the WDOE's 303(d) list for Benzo(A)anthracene, Chrysene, and PCB-1254 (2004). Strong currents and tidal mixing within the entire action area are influenced by the open marine waters of the Guemes Channel. Circulation is primarily influenced by tides and wind. There are no intermittent or perennial streams draining to Puget Sound in the immediate vicinity of the Port of Anacortes.

Nearshore Habitat Quality

The southern shoreline of Guemes Channel in the Action Area has been largely altered by dredging, filling, bulkheads, piers, and marine industries (Grette Associates 2005a). Intertidal habitats contain mud, sand, and gravel/cobble substrates, natural bedrock, and artificial hard substrates such as piling and riprap. Hard substrates below approximately +6 MLLW often support macroalgae dominated by rockweed *(Fucus gardneri),* while unconsolidated sand and mud habitats support annual green algaes such as *Ulva spp.*, and *Enteromorpha spp.* Eelgrass *(Zostera spp.)* occurs where the substrate is undisturbed between MLLW and -13 ft. MLLW.

Approximately 4.92 acres of aquatic habitat within the DCI ship basin will be modified by the project. The habitat types include 2.97 acres of intertidal and shallow subtidal habitat and 1.95 acres of deeper subtidal area. According to surveys conducted in 2003, there is 0.87 acre of eelgrass within the boat basin (Grette Associates 2005b). Because the shallow intertidal habitat in the DCI boat basin will be converted to deep water (-35 ft MLLW) that is unsuitable for eelgrass, the eelgrass will transplanted to the Fidalgo Bay mitigation site.

The substrate in the interidal and shallow subtidal areas is strongly associated with elevation. An aquatic habitat survey conducted by Hart Crowser in 2000 determined that below -0.2 ft MLLW, substrates in the ship basin consist of a layer of unconsolidated silt and sand over dense native material (Port of Anacortes 2004). More than half of the non-eelgrass acreage within the ship basin is shallow sloped intertidal and subtidal mudflats with some areas of riprap along the edge of the boat basin.

According to the aquatic survey, approximately 0.24 acres of the basin is covered by moderately dense macroalgae including *Laminaria sp., Ulva lactuca, Fucus distichus*, and filamentous red algae. Large macroalgae also cover the cobble and some of the riprap along the shoreline. *Ulva lactuca* is the most common macroalgae in the shallow subtital area while Rhodophyta (dominate by Cryptosiphonia sp.) is also present.

Forage fish are expected to occur in the action area. The Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species maps show a documented surf smelt (*Hypomesus pretiousus*) spawning beach just to the west of the drydock(Penttila 1999). Guemes Island and Cypress Island both have extensive sandy beaches conducive to forage fish spawning.

Status of Bull Trout in the Action Area

The action area is within the Puget Sound Management Unit for bull trout, one of two management units identified in the Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of bull trout (USFWS 2004b). This unit is bounded by the Cascade crest to the east, the Kitsap Peninsula on the west, and the Canadian border to north. It includes all watersheds within the Puget Sound basin and marine nearshore of Puget Sound.

The Puget Sound Management Unit includes eight core areas (Chilliwack, Nooksack, Lower Skagit, Upper Skagit, Stillaguamish, Snohomish-Skykomish, Chester Morse Lake, and

Puyallup). Core areas represent the closest approximation of a biologically functioning unit for bull trout (USFWS 2004b). Core areas consist of habitat that could supply all the necessary elements for every lifestage of bull trout (e.g., spawning, rearing, migration, overwintering, foraging), and have one or more local populations of bull trout. Core areas are the basic unit upon which to gauge recovery within a management unit.

The Puget Sound Management Unit contains important foraging, migration, and overwintering habitat (FMO) that is outside of core areas, yet is necessary for bull trout recovery. These FMO areas have been identified in the Draft Recovery Plan as the Samish River, Lake Washington system, Lower Green River, Lower Nisqually River, and marine areas of Puget Sound. Unique to the Coastal-Puget Sound DPS, these areas support the complex migratory behaviors and requirements of anadromous bull trout and are therefore critical to the persistence of that life history form.

The aquatic portions of the action area are within marine FMO. While bull trout have not been documented in the action area, suitable FMO habitat is present, and bull trout are known to occur in adjacent areas. Therefore, it is reasonable to assume that the action area is used by anadromous adult and sub-adult bull trout for foraging, migration, and overwintering. Within the action area it is expected that individual bull trout from the Lower Skagit, Stillaguamish, Nooksack, and Snohomish-Skykomish core areas are most likely to be present (Chan 2005). Thus, the status of each of these core areas is discussed below.

Lower Skagit Core Area

The Lower Skagit core area comprises the Skagit basin downstream of Seattle City Light's Diablo Dam, including the mainstem Skagit River and the Cascade, Sauk, Suiattle, White Chuck, and Baker Rivers, and the lake systems above Shannon and Baker Dams.

Bull trout, which occur throughout the Lower Skagit core area, include fluvial, adfluvial, resident, and anadromous life history forms. Resident life history forms, found in a number of locations in the core area, often occur with migratory life history forms. Adfluvial bull trout occur in Baker and Gorge Lakes. Fluvial bull trout forage and overwinter in the larger pools of the upper portion of the mainstem Skagit River and, to a lesser degree, in the Sauk River (Kraemer 2003a).

Many bull trout extensively use the lower estuary and nearshore marine areas for extended rearing and subadult and adult foraging. Key spawning and early rearing habitat, found in the upper portion of much of the basin, is generally on federally protected lands, including North Cascades National Park, North Cascades Recreation Area, Glacier Peak Wilderness, and Henry M. Jackson Wilderness Area.

<u>Number and Distribution of Local Populations</u>

Nineteen local populations were identified initially: 1) Bacon Creek, 2) Baker Lake, 3) Buck Creek, 4) Cascade River, 5) Downey Creek, 6) Forks of Sauk River, 7) Goodell Creek, 8) Illabot

Creek, 9) Lime Creek, 10) Lower White Chuck River, 11) Milk Creek, 12) Newhalem Creek, 13) South Fork Cascade River, 14) Straight Creek, 15) Sulphur Creek, 16) Tenas Creek, 17) Upper South Fork Sauk River, 18) Upper Suiattle River, and 19) Upper White Chuck River. Although initially identified as potential local populations, Stetattle Creek and Sulphur Creek (Lake Shannon), each now meets the definition of local population based on subsequent observations of juvenile bull trout and prespawn migratory adult bull trout (Shannon 2004; R2 Resource Consultants and Puget Sound Energy 2005). With 21 local populations, the bull trout in the Lower Skagit core area is at diminished risk of extirpation and adverse effects from random naturally occurring events (see "Life History").

Adult Abundance

The Lower Skagit core area, with a spawning population of migratory bull trout that numbers in the thousands, is probably the largest population in Washington (Kraemer 2001a). Consequently, the bull trout population in this core area is not considered at risk from genetic drift. Fewer than 100 migratory adults and a limited number of resident fish use the Forks of the Sauk River; however, the migratory component appears abundant and is increasing (Kraemer 2003b). Fewer than 100 adults probably occur in Tenas Creek, but this local population is presumed to be increasing. The Straight Creek population includes fewer than 100 migratory adults and an unknown number of resident fish (Kraemer 2001b), but the migratory component appears stable. The Lime Creek local population probably has fewer than 100 migratory adults, but resident and migratory components are considered abundant. The South Fork Cascade River local population probably has fewer than 100 migratory adults (Kraemer 2001a); however, resident and migratory components are considered stable. Adult abundances in Newhalem and Stettatle Creeks and Baker Lake are unknown. The majority of local populations in the core area include 100 adults or more. However, some local populations probably have fewer than 100 adults and may be at risk from inbreeding depression.

Productivity

Long-term redd counts in the index areas of the Lower Skagit core area generally indicate stable to increasing population trends.

Connectivity

The presence of migratory bull trout in most of the local populations indicates the bull trout in the Lower Skagit core area has a diminished risk of extirpation from habitat isolation and fragmentation. However, the lack of connectivity of the Baker Lake system and Stetattle Creek in the Gorge Lake system with other occupied sites in the core area is a concern.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, Federal actions occurring in the Lower Skagit core area have caused harm to, or harassment of, bull trout. These actions include statewide Federal restoration programs that include 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 (HCP) addressing forest management practices. Capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Lower Skagit core area.

The number of non-Federal actions occurring in the Lower Skagit core area since the bull trout listing is unknown. Activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably have negatively affected bull trout.

Threats

Threats to bull trout in the Lower Skagit core area include:

- Gorge and Baker Dams restrict connectivity of the Stetattle Creek and Baker Lake bull trout populations with the majority of other populations in the core area.
- Operations of the Lower Baker Dam occasionally have significantly affected water quantity in the Lower Baker and Skagit Rivers.
- Agricultural practices, residential development, and the transportation network, with related stream channel and bank modifications, have caused the loss and degradation of foraging, migration, and overwintering habitats in mainstem reaches of the major forks and in a number of the tributaries.
- Nearshore foraging habitats have been, and continue to be, affected by agricultural practices and development activities.

Stillaguamish Core Area

The Stillaguamish core area comprises the Stillaguamish River basin, including the North Fork and South Fork Stillaguamish Rivers and their tributaries. Major tributaries to the North Fork Stillaguamish River include the Boulder River and Deer, Little Deer, and Higgins Creeks. Canyon Creek, the only major tributary to the South Fork Stillaguamish River, has minor tributaries including Milardy, Deer, Coal, Palmer, Perry, and Beaver Creeks.

Bull trout occur throughout the Stillaguamish River basin and, in the Stillaguamish core area, primarily include anadromous and fluvial life history forms (USFWS 2004b). There are no known populations in the North Fork Stillaguamish River above the barrier to migration at river mile (RM) 37.5. No resident populations have been found above any of the natural migratory barriers on Deer or Higgins Creeks. No exclusively resident populations have been identified in this core area, but the South Fork Stillaguamish River population has a strong resident component coexisting with migratory forms.

The South Fork Stillaguamish River upstream of Granite Falls has supported anadromous bull trout since the construction of a fishway in the 1950s. Previously the falls were impassable to anadromous fish. Anecdotal information from fish surveys in the 1920s and 1930s, however, suggest that native char likely were present above Granite Falls prior to construction of the fishway (WDFW 1998).

Spawning habitat is generally limited in the Stillaguamish core area, and apparently, only the upper reaches provide adequate spawning conditions. Bull trout spawn in the upper reaches of the accessible portions of the upper North Fork Stillaguamish River and its tributaries, including Deer and Higgins Creeks. There has been no extensive juvenile sampling or evaluation of spawning success in the North Fork Stillaguamish River. Bull trout in the Upper Deer Creek local population spawn in Higgins Creek, and spawning also may occur in upper Little Deer Creek. Bull trout spawn in the Boulder River below the impassible falls at RM mile 3. Although unconfirmed, spawning and rearing probably occur in the Squire Creek system, which is similar in size to Boulder River and also influenced by snowmelt. Boulder River may be identified as an additional local population when more distribution information is available.

Spawning areas in the South Fork Stillaguamish River and its tributaries include Canyon, Millardy, Deer, Coal, Beaver (probable spawning), and upper South Fork Stillaguamish. Bull trout are known to spawn and rear in Palmer, Perry, and Buck Creeks, and the upper South Fork mainstem above Palmer Creek. Recent spawning surveys identified a major spawning area above the Palmer Creek confluence. Between 50 and 100 bull trout spawn in this reach. Electrofishing surveys also documented high densities of juveniles (Downen 2003). Spawning and early rearing habitat in the South Fork Stillaguamish River is considered to be in fair condition. Although bull trout spawn in the upper South Fork Stillaguamish River and other tributaries, available habitat is partially limited by gradient and competition with coho salmon (*Oncorhynchus kisutch*). Upstream movement of bull trout from the lower river depends on proper functioning of the fish ladder at Granite Falls. Migratory and resident fish coexist on the spawning grounds.

Bull trout in the Canyon Creek local population use the upper South Fork Stillaguamish River for spawning and rearing. Although there have been isolated and incidental observations of spawning by migratory-size bull trout, electrofishing surveys have been unable to locate any juvenile or resident bull trout from this population. Despite repeated survey efforts, very few bull trout have been located in this population because of the difficulty in locating individuals.

Number and Distribution of Local Populations

Four local populations have been identified in the Stillaguamish core area: 1) Upper Deer Creek, 2) North Fork Stillaguamish River, 3) South Fork Stillaguamish, and 4) Canyon Creek. The scarcity and spatial isolation of available spawning habitat limits the number of local populations in the Stillaguamish core area. With only four local populations, the bull trout in this core area is considered at increased risk of extirpation and adverse effects from random naturally occurring events (see "Life History").

Adult Abundance

The bull trout population in the Stillaguamish River basin is estimated at fewer than 1,000 adults. In the North Fork Stillaguamish River, as many as 100 adult bull trout have been observed holding near the mouth of the Boulder River. Surveys documented nearly 300 adult char between RMs 21 and 25 during fall 2001; fewer than 100 adults were counted in the remaining sample years between 1996 and 2003 (Pess 2003). Other limited snorkel surveys had similar results (Downen 2003). These staging adult bull trout are assumed to spawn somewhere in the North Fork Stillaguamish River. Adult abundance in the Upper Deer Creek and Canyon Creek local populations is considered low. The Boulder River population probably has fewer than 100 adults. Approximately 50 to 100 adults are present in the South Fork Stillaguamish River, based on conservative estimates from spawning and electrofishing surveys (Downen 2003). Although accurate counts are unavailable, current estimates of adult abundance suggest that Upper Deer Creek and Canyon Creek local populations have fewer than 100 adults and are considered at risk of inbreeding depression.

Connectivity

Primary foraging, migration, and overwintering areas in the Stillaguamish River basin include the mainstems of the North Fork and South Fork Stillaguamish Rivers and the Stillaguamish River to the estuary. Foraging subadults and adults may be found in nearly all reaches of the basin below migratory barriers to the basin. Rearing individuals may use nearly all accessible reaches in higher elevation and coldwater portions of the basin. Anadromous forms in the Stillaguamish core area are presumed to use nearshore marine areas in Skagit Bay, Port Susan, and Possession Sound, but may also use areas even farther from their natal basin.

All native char habitat within the Stillaguamish River Basin generally has good connectivity. However, because the local populations are somewhat isolated from one another, maintaining connectivity among them will be critical to support life-history diversity, refounding, and genetic exchange.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, Federal actions occurring in the Stillaguamish core area have caused harm to, or harassment of, bull trout. These actions include five statewide Federal restoration programs that include riparian restoration, restoration of fish passage at barriers, and fish habitat improvement projects. In addition, federally funded transportation projects involving repair and protection of roads and bridges have been completed. Two section 10(a)(1)(B) permits have been issued for HCPs that address bull trout in this core area.

The number of non-Federal actions occurring in the Stillaguamish core area since the bull trout listing is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, negatively affect riparian and instream habitat and bull trout.

Reasons for Decline

Threats to bull trout in the Stillaguamish core area include:

- Channel widening and a significant reduction in primary pool abundance have seriously degraded habitat conditions in the North Fork and lower South Fork Stillaguamish Rivers.

- Spawning habitats in Deer and Canyon Creeks have been extremely degraded.

- Past timber harvest and harvest-related activities, such as roads, have degraded habitat in the Stillaguamish River basin. The loss of riparian cover, slope failures, stream sedimentation, increased stream temperatures, flooding, and loss of large woody debris (LWD) have adversely affected bull trout in Deer Creek and in the South Fork Stillaguamish River (USFWS 2004b). Deer and Higgins Creeks currently violate State water quality standards for temperature.

- Agriculture and residential development have contributed to poor water quality in the lower Stillaguamish River basin. Excessive siltation caused by mud and clay slides on the North Fork Stillaguamish River near Hazel, Washington, and on the South Fork above Robe, contributes to poor water quality (Williams et al. 1975).

- Other limiting factors in the North Fork Stillaguamish River include loss of deep holding pools for adults and low summer flows (USFWS 2004b).

Low flows and high temperatures during the summer affect holding habitat for anadromous migrants in the mainstem Stillaguamish River, especially in the lower river sloughs that have slow-moving water without significant riparian cover (WDFW 1997).

Nooksack Core Area

The Nooksack core area comprises the Nooksack River and its tributaries, including the North, Middle, and South Fork Nooksack Rivers. Fluvial, anadromous and, possibly, resident life history forms of bull trout occur in the Nooksack core area. Bull trout spawning occurs in the North, Middle, and South Fork Nooksack Rivers and their tributaries. Post dispersal rearing and subadult and adult foraging probably occur throughout accessible reaches below barriers to anadromous fish. Overwintering likely occurs primarily in the lower mainstem reaches of the three forks and in the mainstem Nooksack River.

Bull trout and Dolly Varden co-occur in the Nooksack core area, but the level of interaction between the two species and degree of overlap in their distributions is unknown. However, limited genetic analysis and observational data suggest Dolly Varden in this core area inhabit stream reaches above barriers to anadromous fish, while bull trout primarily occupy the accessible stream reaches below the barriers.

Number and Distribution of Local Populations

Ten local populations have been identified: 1) Lower Canyon Creek, 2) Glacier Creek, 3) Lower Middle Fork Nooksack River, 4) Upper Middle Fork Nooksack River, 5) Lower North Fork Nooksack River, 6) Middle North Fork Nooksack River, 7) Upper North Fork Nooksack River, 8) Lower South Fork Nooksack River, 9)Upper South Fork Nooksack River, and 10) Wanlick Creek. Spawning areas in the local populations apparently are small and dispersed. With 10 local populations, the bull trout in this core area are considered at intermediate risk of local extirpation and adverse effects from random naturally occurring events (see "Life History").

Adult Abundance

The Nooksack core area probably supports fewer than 1,000 adults. Eight of the local populations likely have fewer than 100 adults each, based on the relatively low number of migratory adults observed returning to the core area. The Glacier Creek local population has approximately 100 adults, based on incidental redd counts and available spawning habitats. The Upper North Fork Nooksack River local population may support 100 adults, based on the number of persistent, small numbers of spawning adults observed in tributaries and available side channel habitat. The Nooksack core area bull trout population is considered at risk of genetic drift. Although the deleterious effects of inbreeding are minimized in these two local populations, the other eight local populations with few adults are considered at risk of inbreeding depression.

Productivity

The bull trout in the Nooksack core area is considered at increased risk of extinction until sufficient information is collected to properly assess productivity.

Connectivity

There is connectivity among most of the local populations, except for the Middle Fork Nooksack River, which has poor fish passage. There are road culvert barriers in several local populations. Consequently, the bull trout in the Nooksack core area is considered at intermediate risk of extirpation from habitat isolation and fragmentation.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, Federal actions occurring in the Nooksack core area have resulted in harm to, or harassment of, bull trout. These actions include statewide Federal restoration programs that include riparian restoration, restoration of fish passage at 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 HCPs addressing forest management practices. Capture and handling and indirect mortality during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Nooksack core area.

The number of non-Federal actions occurring in the Nooksack core area since the bull trout listing is 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.

Threats

Threats to bull trout in the Nooksack core area include:

- Past timber harvest and harvest-related activities, such as road construction, have caused the loss or degradation of a number of spawning and rearing areas within local populations, as well as foraging, migration, and overwintering habitats.

- The Bellingham water diversion dam has significantly reduced, if not precluded, connectivity of the Upper Middle Fork Nooksack River local population with the rest of the core area.

- Agricultural practices, residential development, the transportation network and related stream channel and bank modifications have caused the loss and degradation of foraging, migration, and overwintering habitat in mainstem reaches of the major forks of the Nooksack River, and in a number of tributaries.

- Marine foraging habitats have been, and continue to be, greatly affected by urbanization along nearshore habitats in Bellingham Bay and the Strait of Georgia.

- The potential for brook trout and brook trout/Dolly Varden hybrids, detected in many parts of the Nooksack core area, to increase their distributions is a significant concern.

Snohomish-Skykomish Core Area

The Snohomish-Skykomish core area comprises the Snohomish, Skykomish, and Snoqualmie Rivers and their tributaries. Bull trout occur throughout the Snohomish River system downstream of barriers to anadromous fish. Bull trout are not known to occur upstream of Snoqualmie Falls, upstream of Spada Lake on the Sultan River, in the upper forks of the Tolt River, above Deer Falls on the North Fork Skykomish River, or above Alpine Falls on the Tye River.

Fluvial, resident, and anadromous life history forms of bull trout occur in the Snohomish River/Skykomish core area. A large portion of the migratory segment of this population is anadromous. There are no lake systems within the basin that support an adfluvial population. However, anadromous and fluvial forms occasionally forage in a number of lowland lakes connected to the mainstem rivers.

The mainstems of the Snohomish, Skykomish, North Skykomish, and South Fork Skykomish Rivers provide important FMO habitat for subadult and adult bull trout. The amount of key spawning and early rearing habitat is more limited, in comparison with many other core areas, because of the topography of the basin. Rearing bull trout occur throughout most of the accessible reaches of the basin and extensively use the lower estuary, nearshore marine areas, and Puget Sound for extended rearing.

The status of the bull trout core area population is based on four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004b).

Number and Distribution of Local Populations

Four local populations have been identified: 1) North Fork Skykomish River (including Goblin and West Cady Creeks), 2) Troublesome Creek (resident form only), 3) Salmon Creek, and 4) South Fork Skykomish River. With only four local populations, bull trout in this core area are considered at increased risk of extirpation and adverse effects from random naturally occurring events (see "Life History").

Adult Abundance

The Snohomish-Skykomish core area probably supports between 500 and 1,000 adults. However, this core area remains at risk of genetic drift. About half of the spawners in the core area occur in the North Fork Skykomish local population. This is one of two local populations in the core area (the other is South Fork Skykomish River) that support more than 100 adults, which minimizes the deleterious effects of inbreeding. The Troublesome Creek population is mainly a resident population with few migratory fish. Although adult abundance is unknown in this local population, it is probably stable due to intact habitat conditions. The Salmon Creek local population likely has fewer than 100 adults. Although spawning and early rearing habitat in the Salmon Creek area is in good to excellent condition, this local population is at risk of inbreeding depression because of the low number of adults. Monitoring of the South Fork Skykomish local population indicates increasing numbers of adult migrants. This local population recently exceeded 100 adults and is not considered at risk of inbreeding depression (C. Jackson, *in litt.* 2004). Fishing is allowed in this system.

Productivity

Long-term redd counts for the North Fork Skykomish local population indicate increasing population trends. Productivity of the Troublesome Creek and Salmon Creek local populations is unknown but presumed stable, as the available spawning and early rearing habitats are considered to be in good to excellent condition. In the South Fork Skykomish local population, new spawning and rearing areas are being colonized, resulting in increasing numbers of spawners. Sampling of the North Fork and South Fork Skykomish local population areas indicates the overall productivity of bull trout in the Snohomish-Skykomish core area is increasing.

Connectivity

Migratory bull trout occur in three of the four local populations in the Snohomish-Skykomish core area (North Fork Skykomish, Salmon Creek, and South Fork Skykomish). The lack of connectivity with the Troublesome Creek local population is a natural condition. The connectivity between the other three local populations diminishes the risk of extirpation of the bull trout in the core area from habitat isolation and fragmentation.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, Federal actions occurring in the Snohomish-Skykomish core area have caused harm to, or harassment of, bull trout. These actions include statewide Federal restoration programs that include riparian restoration, restoration of fish passage at barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges. In addition, section 10(a)(1)(B) permits for HCPs addressing forest management practices typically result in short-term adverse effects and long-term improvements to the environmental baseline. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have also directly affected bull trout in the Snohomish-Skykomish core area.

The number of non-Federal actions occurring in the Snohomish-Skykomish core area since the bull trout listing is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, negatively affect riparian and instream habitat and bull trout.

Reasons for Decline

Threats to bull trout in the Snohomish-Skykomish core area include:

- Past timber harvest and harvest-related activities, such as roads, have degraded habitat conditions in the upper watershed.
- Agricultural and livestock practices, including blocking fish passage, altering stream morphology, and degrading water quality in the lower watershed (FMO habitat), have significantly affected the floodplain and bull trout habitat.
- Illegal harvest or incidental hooking mortality may occur at several campgrounds where recreational fishing is allowed by WDFW.
- Water quality has been degraded by municipal and industrial effluent discharges and development.
- Nearshore foraging habitat has been, and continues to be, affected by development activities.

Due to its distance from the action area, bull trout from the Snohomish River core area are least likely to affected by the proposed project (Chan 2005).

Status of Marbled Murrelets in the Action Area

Conservation Needs of the Marbled Murrelet in the Action Area

The Marbled Murrelet Recovery Plan (USFWS 1997b) outlines the conservation strategy for the marbled murrelet. Of the primary recovery plan recommendations, the following are most pertinent to the needs of marbled murrelets within the action area.

1. Protect the quality of the marine environment essential for marbled murrelet recovery.
2. Reduce adult and juvenile mortality in the marine environment.

The proposed project is located within Conservation Zone 1 (Puget Sound) and includes primarily marine habitat. The recovery plan has identified all water of Puget Sound as essential for marbled murrelet foraging and loafing.

Likelihood of Species Presence in the Action Area

During the breeding season, the marbled murrelet tends to forage in well-defined areas along the coast in relatively shallow marine waters (Strachan et al. 1995). Marbled murrelets forage at all times of the day, and in some cases at night (Strachan et al. 1995).

During the pre-basic molt flightless murrelets must select foraging sites that provide adequate prey resources within swimming distance (Carter and Stein 1995). During the non-breeding season, murrelets typically disperse and are found farther from shore (Strachan et al. 1995).

Marbled murrelet presence in the action area is documented by several sources. The most precise information comes from boat surveys conducted by the U.S. Forest Service, Pacific Northwest Research Laboratory to determine population size and trends under the Northwest Forest Plan Marbled Murrelet Effectiveness Monitoring Program. The action area for this project is encompassed within stratum 2 in Conservation Zone 1 (Puget Sound). Each stratum is divided into "Primary Sampling Units" or PSUs. Each PSU is a rectangular area approximately 20 km long composed of inshore and offshore subunits. PSUs are sampled between May 15 and July 31 (Bentivoglio and others 2002). Density estimates for these data are compiled by the Marbled Murrelet Effectiveness Monitoring team by strata. In stratum 2, murrelet densities have ranged from 1.12 to 1.86 birds per square kilometer (Huff et al. 2003; Lance2004) (Table 4).

Table 4: Marbled murrelet densities in Conservation Zone 1, Stratum 2, based on Effectiveness Monitoring for the Northwest Forest Plan (summer at-sea boat surveys).

Year	Density (birds/km^2)	Source
2000	1.12	(Huff 2003)
2001	1.76	(Huff 2003)
2002	1.86	(Huff 2003)
2003	1.44	(Lance 2004)

The WDFW, in cooperation with the Puget Sound Ambient Monitoring Program (PSAMP) also conducts aerial surveys for seabirds in Puget Sound. These surveys are not specific to marbled murrelets and probably underestimate murrelet presence; however, they provide useful information on the seasonal distribution of marbled murrelets. In the action area, aerial surveys have documented up to five murrelets per square kilometer in the winter (WDFW 2005), and up to two murrelets per square kilometer in the summer (WDFW 2005) (Table 5). And lastly, anecdotal information by a local birdwatcher confirms that murrelets are present year-round in the vicinity of the Anacortes ferry terminal, just to the east of the Port (Bletsch 2004).

Table 5: Marbled murrelet densities in the Action Area based on aerial seabird survey data.

Year/Season	Density (birds/km^2)	Source
1993-2005 Winter	0 – 5.0	(WDFW 2005)
1992-1999 Summer	0 – 2.0	(WDFW 2005)

Based on the information described above, the Service expects that marbled murrelets will be in the action area year-round in relatively low densities.

EFFECTS OF THE ACTION

The "effects of the action" are defined in the section 7 implementing regulations of the Act as "The direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. Indirect effects are those that occur later in time but that are reasonably likely to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration" (50 CFR 402.02).

Direct Effects

Direct effects are the immediate effects of the project on the species or its habitat. Direct effects result from the proposed action and include the effects of interrelated and interdependent actions. The primary direct effects of the proposed project derive from the nature, extent, and duration of the construction activities in the water and the continued operation of the Port and shipyard. Immediate positive effects of the proposed project include the removal of over 1,000 creosote-treated timber piles and restoration of eelgrass habitat. Negative effects may occur from activities such as pile driving and dredging. The installation of steel piles is expected to result in elevated underwater sound pressure levels that could result in adverse effects to bull trout and marbled murrelets. Other negative effects could stem from the expansion of overwater structures, turbidity, and re-suspension of contaminated sediments.

The following outlines the direct effects of the proposed action on listed species and is organized in the order of construction sequencing. Because most of the land-based activities (replacing or upgrading buildings, parking areas, and other infrastructure) will not result in adverse effects to listed species, only the activities that have the potential to affect water quality and/or listed aquatic species will be described in detail:

- Pile removal
- Mitigation
- Dredging
- Pile installation
- New overwater structures

Pile Removal

Approximately 1,000 creosote-treated timber piles will be removed with a barge-mounted crane and then transported to an approved upland disposal site. There are two potential pathways for exposure from contamination resulting from the removal of creosote piles. One pathway is through the water column when piles are extracted and/or cut. Due to the anoxic condition of soils in which piles are submersed, the creosote on the surface of piles remains essentially fresh and is highly volatile in aquatic systems when re-suspended. The second pathway consists of droplets of creosote released from the piles into surrounding sediments as the piles are being pulled. Because these droplets are heavier than water, they are likely to sink to the bottom (Brooks 1994) where they can enter the food chain. Bull trout and marbled murrelets could therefore be directly exposed to contaminants suspended in the water column or indirectly exposed through the food chain.

Creosote contains numerous constituents that are known to be toxic to aquatic organisms (Eisler 1987; Germain et al 1993; Brooks 1994; Brooks 2000; Johnson et al. 2002). Creosote is composed primarily of Polyaromatic Hydrocarbons (PAHs) (about 65 to 85 percent), with smaller percentages of phenolic compounds (ten percent), and nitrogen-, sulfur-, or oxygenated heterocyclics (Brooks 1994; EPRI 1995). Acute exposure to PAHs through the water or sediment can result in narcosis (Van Brummelen et al. 1998), suppressed immune function (Karrow et al. 1999), hormone disruption, and hepatic tumors in fishes (Krahn et al. 1986; Myers et al. 1990; Stein et al. 1990; Johnson et al. 2002).

Studies have shown that high concentrations of toxic chemicals in sediments are adversely affecting Puget Sound biota via detritus-based food webs (Long et al. 2000; Johnson et al. 2002). Because PAHs tend to adsorb to sediments when sediment is undisturbed, only a portion of parent PAH compounds are readily bioavailable to marine organisms. However, resident benthic organisms may be exposed to PAHs through their diet, through exposure to contaminated water in the benthic boundary layer, and through direct contact with the sediment (Johnson et al. 2002). PAHs may bioaccumulate in aquatic invertebrates within these benthic communities (Varanasi et al. 1993; Meador et al. 1995). Vertebrates quickly metabolize some of the lighter PAH compounds (McElroy et al. 1991) and can pass the contamination on to marine fish and seabirds that consume them.

The potential for environmental exposure to creosote is dependent on the age of the treated wood, methods used to treat the product, a host of environmental parameters, and the dilution afforded by the receiving body of water. Bull trout, marbled murrelets, and their prey could be exposed to creosote and PAHs when the pilings are removed. However, because of the high degree of disturbance associated with dredging and other construction activities, bull trout and murrelets are not expected to forage or linger in the vicinity of the boat basin long enough to be exposed to levels of creosote that could cause cytotoxicity or tumor induction.

Effects of Creosote Exposure on Bull Trout

Data regarding the toxicity of contaminants to bull trout are limited. Hansen et al. (2002) found it difficult to extrapolate existing data and apply them to bull trout because of the behavioral and physiological differences between bull trout and fish species generally used in freshwater toxicity studies. The naturally slow and highly variable growth rates of bull trout can make it difficult to find statistically significant differences between treatment and controls, regardless of the obvious trends (Hansen et al. 2002).

Bull trout that are in the action area could be exposed to creosote and its associated contaminants during the removal of over 1,000 creosote piles. However, creosote and associated compounds are hydrophobic and will adhere to particulate matter in the water column and eventually settle out into the bottom sediments (Johnson et al. 2002). Because of this, we expect waterborne creosote concentrations to be negligible within a week of re-suspension (Davis 2005). Toxins that settle out will be removed during the dredging operations.

The duration of exposure to creosote-related contaminants will be relatively short (approximately 2 months during the first in-water work period). Less than 2 percent of the bull trout observations have been documented in the marine water during the work window (Goetz et al. 2004). While a few sub-adult and adult bull trout may be present the action area during the in-water work period, these age classes are migratory and are not expected to linger or spend multiple days in the action area, especially the boat basin during construction. Because the likelihood and duration of exposure to creosote-related contaminants in the water column is extremely low, the Service does not anticipate that bull trout will be measurably affected as a result of exposure to chemicals from pile removal.

In the long term, the removal of more than 1,000 creosote-treated wood piles is expected to improve water quality for bull trout and their prey by decreasing concentrations of creosote in the environment and eliminating the source of chronic contamination of benthic invertebrates.

Effects of Creosote Exposure on Marbled Murrelets

There are no data on the effects of creosote and PAHs on marbled murrelets, and limited data on the effects to other birds. Fry (1995) reports that within the range of marbled murrelets, non-PAH compounds represent the most prevalent pollutant risk. Pollutant monitoring of pigeon guillemots (*Cepphus columba*) in Washington State indicated that birds from the Strait of Juan de Fuca were less contaminated than those captured near Seattle, presumably because contaminated forage fish

do not move widely throughout Puget Sound (Calambokidis et al. 1985). Fry (1995) concluded that the risk to marbled murrelets of exposure to bioaccumulating chemicals and toxins in the environment would be similar to pigeon guillemots. Marbled murrelets feed on invertebrates as well as vertebrate species (see the Foraging section under Marbled Murrelet Status of the Species). Therefore, there is the potential for exposure to toxins through the food chain.

Like bull trout, marbled murrelets can be affected by creosote contamination through the water column and food chain. Based on the survey data (WDFW 2005), murrelet densities in Guemes Channel are higher in the winter (2-5 birds/km^2) than the summer (< 1 bird/km^2). Habitat conditions and foraging opportunities are much better in Guemes Channel and marbled murrelets are not expected to spend much time in the confined and busy boat basin, especially during dredging and construction. Because the likelihood of murrelets being in the boat basin or near the piers during pile removal is extremely low, effects to marbled murrelets from direct exposure to creosote is considered insignificant.

The removal of over 1,000 creosote-treated piles is expected to result in long-term improvements of water quality and reduce the potential for bioaccumulation of toxins through the food chain by eliminating a source of chronic contamination of benthic invertebrates. Most of the creosote in the substrates will be removed during dredging. Because removal of the piles will reduce the amount of toxins in the marine environment, long-term effects of this part of the proposed action are considered beneficial.

Mitigation

Removal of Fill

To compensate for the loss of shallow water habitat in the boat basin, the Port is proposing to remove upland fill at two locations near the DCI shipping basin to create intertidal and/or subtidal habitat at a 1:1 replacement ratio. Approximately 1 acre of upland area at the Log Pocket mitigation site will be converted to intertidal habitat and 0.06 acres of intertidal habitat will be restored at the O Avenue site. The habitat restoration activities will be performed at low tide to avoid in-water construction effects.

The long-term effect of creating aquatic habitat where none presently exists will benefit bull trout. The total area of intertidal habitat creation will equal the amount that is being converted to upland or deepwater habitat due to construction. The Log Pocket area is better suited for fish because most operations and other disruptive activities will cease after the site is created whereas the existing habitat in the boat basin is subject to high levels of disturbance. Both restoration sites will be completed during construction of the new berthing area. This will reduce the temporal loss of habitat between construction and mitigation.

Transplanting Eelgrass to Fidalgo Bay

To compensate for the loss of 0.86 acres of eelgrass within the DCI shipping basin, the Port proposes to transplant the eelgrass from the boat basin and plant additional eelgrass at a nearby

site in Fidalgo Bay. Fidalgo Bay supports a herring population that is an important food source for bull trout and other salmonids. Approximately 2.3 acres of new eelgrass will be planted as mitigation for this project (net replacement ratio of 1.5 to 1).

Clean dredge spoils from routine maintenance dredging of the Swinomish Channel will be used to fill areas within Fidalgo Bay that had been previously dredged and restore the original shallow water habitat and create a suitable planting area for eelgrass. Approximately 6 acres of shallow water area will be created in the bay and will serve as a mitigation bank for several ongoing projects in the area. In order to meet the performance standards outlined in the planting plan, the Port may need to supplement the transplants with additional eelgrass turions from a stocked source.

The Corps will oversee the creation of the Fidalgo Bay mitigation site as part of their navigational channel dredging operations. The Port is responsible for transplanting and ensuring survival of the eelgrass related to the DCI Pier I expansions and operations. Consultation for the creation of the mitigation bank in Fidalgo Bay was covered under the Swinomish Channel Maintenance Dredging (FWS Ref: #1-3-06-I-0061). Because the mitigation site is better habitat than the boat basin, the long-term effects of the eelgrass mitigation are expected to be improved habitat conditions and increase food availability for bull trout and other salmonids in northern Puget Sound.

Monitoring of Mitigation Projects

Salmonids (including bull trout) are likely to be captured and handled during fish sampling at the Log Pocket and O Avenue mitigation sites. The Port will collect fish with seine nets to determine the biological health and recovery of the restoration site. Although the sampling effort is geared to juvenile salmonids and forage fish, there is a small chance that bull trout may be captured. In 2003, three subadult and adult bull trout were captured near Bowman Bay on the southern end of Fidalgo Island during a beach seining demonstration for a middle school project. Because fish sampling will be conducted annually over a 10-year period, the Service anticipates that a small number of subadult or adult bull trout may be captured during the monitoring efforts. All fish that are collected will be measured and released as quickly as possible.

<u>Dredging</u>

Effects of Dredging on Bull Trout

To increase the size and depth of the DCI shipyard basin, the Port is proposing to remove approximately 168,000 cy^3 of material and deepen the boat basins to a uniform depth of -35 MLLW. This will result in the permanent loss of approximately 3.86 acres of shallow, intertidal habitat. Sediments will be removed using either a hydraulic or barge-mounted clamshell dredge. All but 11,500 cy^3 of material will be taken to the approved open water disposal site in Rosario Strait. Because the top layer of material is contaminated and does not meet the criteria for open water disposal, it will be transported to an approved upland facility.

The potential mechanisms by which dredging could affect bull trout include direct mortality, injury by entrainment, sublethal effects (stress, gill damage, and increased-susceptibility to disease), and behavioral responses (disruptions to feeding or migration) (PIE 2001). The potential risk of exposure will be reduced by the dredging schedule, which is limited to the time of year when few bull trout are likely to be present in the action area.

Long-term ecosystem effects of dredging include changes in the volume and area of habitat, periodic changes to primary and secondary production (food web effects), and changes in hydrodynamics and sedimentology (Nightingale and Simestad 2001).

Biological effects to bull trout from dredging are expected from: 1) temporary reductions in water quality from suspended sediment associated with dredging that could reduce or preclude bull trout foraging in the affected area, 2) temporary loss of benthic organisms and other prey due to disturbance of the sediment substrates, and 3) potential exposure to contaminants.

Water Quality -Turbidity

Dredging activities disturb and suspend sediment, creating discoloration of the water, reducing light penetration and visibility, and changing the chemical characteristics of the water. The size of the sediment particles and tidal currents are typically correlated with the duration of sediment suspension in the water column. Larger particles, such as sand and gravel, settle rapidly, but silt and very fine sediment may be suspended for several hours. Lasalle (1988) described a downstream plume that extended 900 ft at the surface and 1,500 ft at the bottom and noted a 70 percent increase in sediment levels as the bucket descended through the water.

The effects on water quality (suspended sediments and chemical composition) from dredging can have a detrimental impact on salmonids. Suspended sediments can have an adverse effect on migratory and social behavior as well as foraging opportunities (Bisson and Bilby 1982; Sigler et al. 1984; Berg and Northcote 1985). Servizi (1988) observed an increase in sensitive biochemical stress indicators and an increase in gill flaring when salmonids were exposed to high levels of turbidity. Gill flaring allows the fish to create sudden changes in buccal cavity pressure, which is similar to a cough.

Chemical composition of the water with suspended sediments is also affected by dredging activities. Estuarine sediments are typically anaerobic and create an oxygen demand when suspended in the water column, which in turn decreases DO levels (Morton 1976; Hicks et al. 1991). A review of the processes associated with DO reduction (Lunz and LaSalle 1986; Lunz et al. 1988) suggested that DO demand of suspended sediment is a function of the amount of material placed into the water, the oxygen demand of the sediment, and the duration of suspension. The DO reductions appear to be most severe lower in the water column, and usually the condition reverses with adequate tidal flushing (LaSalle 1988). Most of the research reported to date indicated that dredging-induced DO reductions are a short-term phenomena and do not cause long-term problems in most estuarine systems (Slotta et al. 1974; Smith et al. 1976; Markey and Putnam 2007). To comply with water quality certification requirements, the Port is required to monitor turbidity levels during dredging.

Decreases in DO levels have been shown to affect swimming performance levels in salmonids (Bjornn and Reiser 1991). The decrease of swimming performance due to decreases in DO can be expected to affect the bull trout's ability to escape potential predation or could affect its ability to forage on motile fish. Lasalle (1988) found a decrease in DO levels from 16-83 percent in the mid- to upper water column and nearly 100 percent close to the bottom. Since bull trout are associated with the bottom, this extreme decrease in DO could directly affect their ability to survive. Smith et al. (1976) found DO levels below 2.9 milligrams per liter (mg/L) during dredging activities in Grays Harbor. Hicks (1991) observed salmon avoidance reactions when DO levels dropped below 5.5 mg/l. Dredging fine sediments, such as those found in the boat basin, will create a sediment plume that may not disperse rapidly because of the confined nature of the basin and lack of tidal flushing. This could create poor water quality (i.e., decreased DO levels) that likely will cause bull trout to avoid the boat basin during dredging.

Dredging will be conducted using mechanical equipment consisting of a barge-mounted crane fitted with a clamshell bucket or hydraulic dredge. The top layer of sediment in the boat basin does not meet the criteria for open water disposal due to the presence of industrial toxins. Contaminated sediments will be removed using an environmental bucket and sealed hold on the barge to prevent leakage. Clamshell dredging causes very limited, short-term localized turbidity. No long-term effects would result from this turbidity. The amount and duration of turbidity during mechanical dredging will be controlled by adhering to the BMPs and conditions outlined in the 404 permit. The potential effects of exposure to elevated levels of turbidity will be minimized by implementing the in-water work window and using barge operating procedures to minimize water quality impacts. In a similar dredging project in Puget Sound, the overwhelming majority of turbidity readings ranged from 0.5 to 1.8 Nepholometric Turbidity Units (NTU) at 150 ft and/or 300 ft downflow of the dredge, well below the 5 NTU threshold set by state of Washington water quality certification standards (Roni and Weitkamp, 1996). LaSalle (1988) reported upper limits of turbidity from dredging from 700 to 1,100 mg/L suspended sediments. At those levels, the risk of mortality or gill damage to adult and subadult bull trout would be negligible.

Due to the confined nature of the boat basin, turbidity is expected to increase in the project area during dredging operations, even with implementation of the conservation measures. To limit effects of elevated turbidity and exposure to contaminants on adult and subadult bull trout, dredging will be conducted during the time of year when few bull trout are expected to be present in the action area.

Sediment removal is expected to take approximately 22 weeks and will be conducted over the course of two work windows. The Port intends to meet performance standards set forth by the Endangered Species Act, Clean Water Act, and other various environmental regulations. Because the boat basin is a confined area and any suspended sediments that enter Guemes Channel will be quickly diluted and transported by tidal currents, effects of turbidity from dredging is anticipated to be limited to the dredge area.

Sub-adult and adult bull trout may be present in Guemes Channel in low numbers during the approved in-water work period. These age classes are very mobile and may temporarily move to

deeper water or adjacent habitats in response to elevated levels of turbidity. Displacement is most likely to occur on weekdays and during daylight hours when the barge is operating. Water quality should return to near normal levels within a few hours after the operations shut down for the day. Because the boat basin does not provide good habitat for bull trout and dredging operations will not preclude bull trout from migrating along the shoreline, effects to migratory and foraging bull trout from turbidity are considered insignificant.

Effects of Dredging on Marbled Murrelets

The inner boat basin is very shallow (reason for dredging) and does not provide good foraging opportunities for marbled murrelets. Furthermore, the level of disturbance associated with regular shipyard activities likely precludes murrelets from using the boat basin. Murrelets are especially unlikely to be in the area during dredging operations because the re-suspension of sediments severely reduces visibility. Because we do not expect marbled murrelets to occur in the DCI boat basin during dredging, effects to marbled murrelets from elevated levels of turbidity are considered discountable.

Effects of Dredging on Benthic Organisms and Forage Fish Habitat

Dredging operations will impact approximately 126,000 ft^2 of benthic habitat. Disruption of the channel bottom and entrainment by dredging has a negative impact on sessile organisms and benthic biota. Dredging physically disturbs the bottom, eliminating or displacing established benthic communities, thus reducing prey availability to bull trout and other salmonids. Filter feeding benthic organisms can suffer from clogged feeding structures, reduced feeding efficiency, and increased stress levels (Hynes 1970). Dredging may also suppress the ability of some benthic species to colonize the dredged area, thus resulting in a loss of food sources for bull trout prey species. We believe the negative impact to bull trout will be insignificant, especially given the degraded habitat conditions in the boat basin. The affected area represents a very small percentage of the marine foraging habitat in the area and the benthic community is expected to recover and within one to two years. Finally, because the existing surface layer is contaminated, we anticipate that removing the top layer will provide improved substrate conditions for benthic organisms in the project area over the long term.

However, the substrate community composition will be different than what currently exists because the dredging will convert 3.86 acres of shallow intertidal habitat to deepwater habitat (-35 MLLW). This will preclude the establishment of aquatic vegetation and other organisms that require sunlight. Since the loss of shallow intertidal habitat in the DCI boat basin will be mitigated at a 1:1 replacement ratio, no net loss of aquatic vegetation or benthic species diversity is anticipated. The shallow intertidal habitat at the shipyard does not contain suitable substrate material for forage fish and no spawning has been documented in the DCI boat basin. Surf smelt spawning has been documented at a beach approximately 0.2 mile to the west of the shipyard and it is anticipated that the habitat mitigation at the Log Pocket, O Avenue site, and the eelgrass mitigation site in Fidalgo Bay will create suitable spawning and rearing areas for forage fish in the future.

Pile Installation

Before evaluating the effects of impact pile driving, we would like to provide an overview of the physics and terminology for sound and underwater pressures associated with pile installation and removal.

Review of Acoustic Concepts and Terminology - In Brief

Frequency is the rate of oscillation or vibration of sound measured in cycles per second, or hertz. 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). Many animals can detect ultrasound and some animals, including pigeons, can detect infrasounds (Richardson et al. 1995). Sound is usually measured in decibels. A decibel (dB) is a relative measure that must be accompanied by a reference scale. When describing underwater sound pressure, the reference is usually 1 micro-pascal (μPa) and is expressed as "dB re: 1 μPa." One pascal is the pressure resulting from a force of 1 newton exerted over an area of 1 square meter. In this document, underwater sound is referred to in units of decibels re: 1 μPa and will be denoted as dB.

For in-air sound pressure, the reference amplitude is usually 20 μPa. In-air sound, measured on an A-weighted scale (which approximates human hearing), will always be re: 20 μPa in this document and will be denoted as dBA. The peak sound emitted in air from a source is referred to as dB_{peak}, while sound averaged over a measured period of time is referred to as dB_{rms}.

Root-mean-square (rms) sound pressure level (SPL) is often used in the context of discussing behavioral effects. Behavioral effects, which often result from auditory cues, and effects on hearing, may be better expressed through averaged units rather than by peak pressures. RMS is the root square of the energy divided by the duration.

Positive impulse is the integral of pressure over time, from arrival of the leading edge of the pulse until the pressure becomes negative. Impulse is measured in pascal-seconds (Pas). When discussing the effects of explosions on animals, authors often use impulse as the acoustic parameter, as in Yelverton et al. (1973) discussed below.

As sound propagates away from a source, several factors change its amplitude. These factors include 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 the surface of the sea floor (in the case of underwater sound). The sum of all propagation and loss effects on a signal is called the transmission loss. A major component of transmission loss is spreading loss. From a point source in a uniform medium (water or air), sound spreads outward in spherical waves. Spherical spreading implies that intensity varies inversely with the square of the distance from the source. With spherical spreading, sound levels diminish by 6 dB when the distance is doubled. Sound transmission in shallow water is highly variable and site specific. Refraction can result in either reduced or enhanced sound transmission in shallow water (Richardson et al. 1995).

Ambient sound is the background noise. In the ocean, sources of ambient sound include wind, waves, organisms, shipping traffic, rain, and more. In air, ambient sound sources commonly include wind, rain, traffic, etc. Since 1950 oceanic ambient sound levels have risen by as much as 10 dB, mostly due to commercial shipping (U.S.Department of Defense 2002).

The interface between air and water acts as a very effective reflector, a phenomenon referred to as the "Lloyd mirror effect." Because little energy will pass this reflector, sound generated in the water will not pass into the air and vice versa.

Effect of Underwater SPLs from Impact Pile Driving

High underwater SPLs are known to have negative physiological and neurological effects on a wide variety of vertebrate species including fishes and birds (Yelverton et al. 1973; Yelverton and Richmond 1981; Steevens et al. 1999; Fothergill et al. 2001; Cudahy and Ellison 2002; U.S. Department of Defense 2002). High underwater SPLs are known to injure and/or kill fishes by causing barotraumas (pathologies associated with high sound levels including hemorrhage and rupture of internal organs), as well as causing temporary stunning and alterations in behavior (Turnpenny and Nedwell 1994; Turnpenny et al. 1994; Popper et al. 2003; Hastings and Popper 2005). In controlled experiments using underwater explosives, rapid change in SPLs caused internal hemorrhaging and mortality in submerged mallard ducks (*Anas platyrhnchos*) (Yelverton et al. 1973). Risk of injury appears related to the effect of rapid pressure changes, especially on gas-filled spaces in the bodies of exposed organisms (Turnpenny et al. 1994). In studies on ducks (*Anas spp.*) and a variety of mammals, all species exposed to underwater blasts had injuries to gas filled organs including eardrums (Yelverton and Richmond 1981). These data indicate that, at a coarse scale, physical responses may be similar across taxonomic groups.

High underwater SPLs can also cause a variety of behavioral responses that have not been well studied. Broadly, the effects of elevated underwater SPLs on organisms range from death to no effect. Over this continuum of effect, there is no easily identifiable point at which behavioral responses transition to physical effects. For the purposes of this analysis, we attempt to group the effects into these two categories as they are roughly correlated with the Endangered Species Act definition of harm (those causing injury and/or death) and harassment (those causing significant behavioral changes). General literature and information on each category are described first, with the potential effects to both bull trout and marbled murrelets described more specifically in subsequent sections.

Effects from Impact Installation of Steel Piles Expected to Result in Mortality or Injury

Injury and mortality in fishes has been attributed to impact pile driving (Stotz and Colby 2001; Stadler 2002; Fordjour 2003; Abbott et al. 2005; Hastings and Popper 2005). The injuries associated with exposure to high SPLs are referred to as barotraumas, and include hemorrhage and rupture of internal organs, hemorrhaged eyes, and temporary stunning (Yelverton et al. 1973; Yelverton et al. 1975; Yelverton and Richmond 1981; Turnpenny et al. 1994; Hastings and Popper 2005). Death from barotrauma can be instantaneous, occurring within minutes after exposure, or several days later (Abbott 2002). The most noticeable and documented effects of

pile driving have been fish kills. However, it is important to note that not all fishes killed by pile driving float to the surface and therefore go undetected (Teleki and Chamberlain 1978; WSDOT 2003). With few exceptions, fish-kills are reported only when dead and injured fishes are observed at the surface. Thus, the frequency and magnitude of such kills are usually underestimated.

Physical injury to aquatic organisms may not result in immediate mortality. If an animal is injured, death may occur several hours or days later, or injuries may be sublethal. Necropsy results from Sacramento blackfish (*Othodon microlepidotus*) exposed to high SPLs showed fish with extensive internal bleeding and a ruptured heart chamber were still capable of swimming for several hours before dying (Abbott et al. 2002). Sublethal injuries can interfere with the ability to carry out essential life functions such as feeding and predator avoidance (Popper 2003).

There are no empirical data specific to impact pile driving and its effects on marbled murrelets, or any other seabird. However, studies that have evaluated other types of underwater sounds on a variety of vertebrate species provide some basis for evaluating the effects of the high SPLs generated by pile driving on marbled murrelets. Data related to seabirds is primarily limited to evaluations of the effects of underwater blasting and seismic testing (Yelverton and Richmond 1981; Cooper 1982; Stemp 1985; Flint et al. 2003; Lacroix et al. 2003). Recent anecdotal information collected during monitoring of seabird response to pile driving in Hood Canal, Washington, revealed a behavioral response to impact pile driving from an alcid related to marbled murrelets (Entranco, Inc. and Hamer Environmental, L.P. 2005). During monitoring, a pigeon guillemot (*Cepphus columba*) dove within 75 m of an operating pile driver and quickly surfaced. It was then observed having difficulty getting airborne and shaking its head. Although it was eventually able to fly out of the area, this individual probably experienced an increased vulnerability to aerial predators and temporarily reduced foraging efficiency.

The potential for injury and/or mortality of any aquatic organism from pile driving depends on the type and intensity of the sounds produced. These are greatly influenced by a variety of factors, including the type of hammer, the type of substrate, and the depth of the water. Firmer substrates require more force for pile installation, resulting in more intense sound pressures. Key variables that factor into the degree to which an animal is affected include size, anatomical variation, and position of the organism in the water column (Gisiner et al. 1998). Any gas-filled structure within an animal is particularly susceptible to the effects of underwater sound (Gisiner et al. 1998). Examples of gas-filled structures in vertebrate species are swimbladders, bowel, sinuses, lungs, etc. As sound travels from a fluid medium into these gas-filled structures there is a dramatic drop in pressure which can cause rupture of the hollow organs (Gisiner et al. 1998).

Sound energy from an underwater source readily enters the bodies of animals because the acoustic impedance of animal tissue nearly matches that of water (Hastings 2002). This has been demonstrated in fishes with swimbladders (such as salmonids). As a sound pressure wave passes through a fish, the swimbladder is rapidly compressed due to the high pressure and then rapidly expanded by the underpressure. At the high SPLs associated with pile driving, the swimbladder may repeatedly expand and contract. This essentially hammers adjacent tissue and organs that are bound in place near the swimbladder (Gaspin 1975). Exposure to this type of pneumatic

pounding can cause rupture of capillaries in the internal organs, as observed in fishes with blood in the abdominal cavity, and maceration of kidney tissues (Abbott and others 2002; Stadler 2002).

Yelverton and Richmond (1981) and Yelverton and others (1973) exposed many fish species, various birds, and terrestrial mammals to underwater explosions. Common to all the species that were exposed to underwater blasts were injuries to air and gas-filled organs, as well as eardrums. These studies identified injury thresholds in relation to the size of the charge, the distance at which the charge was detonated, and the mass of the animal exposed. The research found that greater impulse levels are needed to cause an injury to larger organisms while animals with smaller mass sustained injury from smaller impulses.

Fishes may react to the first few strikes of an impact hammer with a "startle" response. After these initial strikes, the startle response wanes and the fishes may remain within the field of a potentially harmful sound (Dolat 1997). The sounds from impact driving of steel piles are too brief to elicit an avoidance response, which requires longer duration and lower frequencies than are typically produced by this activity (Enger et al. 1993; Dolat 1997; Knudsen et al. 1997; Sand et al. 2000; Carlson et al. 2001). Thus, impact hammers may be harmful for two reasons: first they produce pressure waves with potential to harm fishes and, second, the sounds produced do not elicit an avoidance response in fishes, which may expose them for long periods to those harmful pressures.

At Bremerton, Washington, approximately 100 surfperch (*Cymatogaster aggregata, Brachyistius frenatus* and *Embiotoca lateralis*) were killed during impact driving of 30-in diameter steel pilings (Stadler 2002). The size of these fish ranged from 70 mm to 175-mm fork length. Dissections revealed that the swimbladders of the smaller fish were completely destroyed, while those of the larger individuals were nearly intact. Damage to the swimbladder of *C. aggregata* was more severe than to similar-sized *B. frenatus*. These results are consistent with the observations of Yelverton and others (1975) who also found size and/or species differences in injury from underwater explosions.

Another mechanism of injury and death resulting from high SPLs is "rectified diffusion," or the formation and growth of bubbles in tissue. Rectified diffusion can cause inflammation and cellular damage because of increased stress and strain (Vlahakis and Hubmayr 2000; Stroetz et al. 2001) and blockage or rupture of capillaries, arteries, and veins (Crum and Mao 1996). Crum and Mao (1996) analyzed bubble growth underwater by rectified diffusion caused by sound signals at low frequencies (less than 5,000 Hz), long pulse widths, and atmospheric pressure. Their analysis indicated that SPLs exceeding 190 dB_{peak} could cause bubble growth.

Due to differences between species and variation in exposure type and duration, there is some uncertainty as to the degree of potential adverse effects from SPLs between 180 and 190 dB_{peak}. Turnpenny and others (1994) exposed brown trout (*Salmo trutta*) to SPLs greater than 170 dB with pure tone bursts for a duration of 90 seconds. This resulted in 57 percent mortality after 24 hours. The same study conducted on bass (*Dicentrarchus labrax*) and whiting (*Merlangius merlangus*) using a SPL of 176 dB (95 Hz) resulted in a mortality rate of 50 percent. The authors

suggest that the threshold for continuous sounds was lower than for pulsed sounds such as blasts. Sounds from pile driving are more similar to airgun blasts than to pure tone bursts. As such, we conclude that the 170 dB threshold for injury to brown trout identified by Turnpenny is likely lower than the injury threshold level anticipated for pile driving from this project.

Based on the research, we anticipate the potential for barotrauma to occur in aquatic organisms, including marbled murrelets (when diving), bull trout, and forage fish, at SPLs of $\geq$ 190 dB_{peak}. We anticipate other types of potential physical injury to occur above 180 dB_{peak}, based on the studies of both aquatic and terrestrial species discussed above. The 180 dB_{peak} threshold is probably at least somewhat conservative because most studies described evaluated transmitted signals of longer duration that what is anticipated to result from pile driving. The potential adverse effects specifically anticipated for both marbled murrelets and bull trout are described in more detail below.

Effects of Impact Installation of Steel Piles Expected to Result in Significant Alteration of Normal Behavior in Bull Trout and Marbled Murrelets

There are no experimental data available specific to bull trout or marbled murrelet response to underwater sound from pile driving. In fact, there is much uncertainty regarding the behavioral response of organisms to underwater sound in general. Further confounding the issue is the fact that most of the information on the behavioral effects of underwater sound is from studies using pure tone sounds. Because the sounds generated by pile driving are impulsive sounds that are made up of multiple frequencies and tones, comparison with the research results is difficult. Additionally, the few data that exist are focused primarily on the response of humans, marine mammals, and fishes and do not include effects on diving birds. We must therefore extrapolate from these data in order to evaluate potential effects to marbled murrelets.

Exposure to elevated SPLs can result in temporary hearing damage referred to as Temporary Threshold Shift (TTS). Most bioacoustic specialists consider TTS to be physiological stress, rather than injury (Popper et al. 2006). Nonetheless, an organism that is experiencing TTS may not be able to detect relevant sounds such as approaching predators, prey, or mates that are attempting to communicate. During seabird monitoring for the Hood Canal Bridge project, a pigeon guillemot appeared disoriented and was observed having difficulty getting airborne after being exposed to underwater sound from impact pile driving (Entranco, Inc. and Hamer Environmental, L.P. 2005). It is reasonable to assume that this individual was suffering from TTS and that the behavior it was exhibiting could have made it vulnerable to predation. The same scenario is expected for fish species. Mesa (1994) examined predator avoidance ability and physiological response of Chinook salmon subjected to various stressors. The test fish were agitated to cause disorientation and injury. When equal numbers of stressed and unstressed fish were exposed to predators, there was significantly more predation of stressed fish.

Additionally, Turnpenny and others (1994) attempted to determine a level of underwater sound that would elicit behavioral responses in brown trout, bass, sole, and whiting. With brown trout an avoidance reaction occurred above 150 dB_{rms} and startle responses were noted at 170-175 dB_{rms}. The report references Hastings' "safe limit" recommendation of 150 dB_{rms} and concludes

that the limit provides a reasonable threshold for harm/injury. In an associated literature review, Turnpenny and Nedwell (1994) also state that the Hastings' 150 dB_{rms} limit seemed justifiable. Observations by Feist and others (1992) also suggest that sound levels in this range may disrupt normal migratory behavior of juvenile salmon.

More recently, Fewtrell (2003) held fish in cages in marine waters and exposed them to seismic airgun impulses. The study detected significant increases in behavioral responses at sound pressure levels of 158 – 163 dB_{rms}. Responses included startle reactions, increased swimming speed, tighter groups, and movement toward the lower portion of the cage. The study also evaluated physiological stress response by measuring plasma cortisol and glucose levels but found no statistically significant changes. However, Santulli and others (1999) did find evidence of increased stress hormones after exposing caged European bass to seismic survey sound.

Clearly, there is a substantial gap in scientific knowledge on this topic. The most recent study by Fewtrell presents some experimental data on behavioral responses of fishes to impulsive sounds above 158 dB_{rms}. Given the large amount of uncertainty that lies in extrapolating from experimental data to the field, between sound sources, and from one species to another, we believe it is appropriate to utilize a conservative threshold. As such, for the purposes of this analysis, the Service will anticipate that SPLs in excess of 150 dB_{rms} are likely to cause significant behavioral changes in both bull trout and marbled murrelets.

Estimating the Extent of Effect

To estimate the geographic area in which effects are expected, the distance at which transmission loss (TL) attenuates the pressures to below the thresholds must be estimated. Calculating TL is extremely complicated, and is likely to be site-specific. In the past, the Service has relied on a cylindrical spreading model [TL = 10*Log (R), where R = range or distance from the source] or spherical spreading model [TL = 20*Log(R)] to estimate TL. However, (Reyff 2003) provided hydroacoustic monitoring data which suggest that the actual spreading loss may be intermediate between cylindrical and spherical spreading. Therefore, a practical spreading model, as described by (Davidson 2004) [TL = 10*Log(R)] is more appropriate. The practical spreading model is used to estimate the distances at which injury and behavioral disruption are expected. This model assumes that SPLs decrease at a rate of 4.5 dB per doubling distance under water and 6 dB per doubling distance in air.

Methods to Reduce Underwater Sound Pressure Levels

Air bubbles can be used to attenuate underwater sound (Gisiner and others 1998). Air bubbles are most effective at moderate to high frequencies but are also useful for low frequency sounds and have been known to reduce sound pressure levels by as much as 30 dB at some frequencies (Gisiner and others 1998). During demolition of a dam on the Mississippi River, Keevin and others (1997) found a significant reduction in mortality of caged bluegill (*Lepomis macrochirus)* with use of a bubble curtain. Bubble curtains can also reduce particle velocity levels (MacGillivray and Racca 2005).

In recent years, bubble curtains have been used on an increasing number of pile installation projects, primarily on the west coast. Designs have varied and are largely experimental. Effectiveness has also varied widely and is likely to be influenced by factors such as design, site conditions, and the ability for construction contractors to correctly implement the system. Improper installation and operation can decrease effectiveness. Problems with implementation have been observed on a number of projects (Laughlin 2005; Pommerenck 2006).

On a bridge project in California, installation of very large piles (98-in diameter) within an isolation casing combined with an air bubble curtain resulted in significant sound pressure attenuation while a similar project on the San Joaquin River using an attenuation system consisting of an isolation casing with a bubble curtain on the inside achieved much less attenuation (between 6-9 dB) (Pommerenck 2006). However, this project had problems correctly implementing the system. During impact installation of steel piles in an embayment on the Columbia River, a bubble curtain built using the Longmuir and Lively (2001) design achieved a maximum reduction of 17 dB, although the results were variable (Laughlin 2006). A test of bubble curtain effectiveness in Friday Harbor, Washington, found improvements were seen after the original design was modified on site to improve contact with the substrate. After modification, the bubble curtain was achieving a 12 dB reduction which equates to an 85 percent reduction in peak overpressure (Laughlin 2005). Use of a bubble curtain while installing 24-in diameter steel piles at a marina in Washington resulted in reductions of 10-15 dB (Houghton and Smith 2005). These examples illustrate the high degree of variability seen with use of air bubble attenuation systems and the influence of design, site conditions, and contractor implementation. When correctly implemented, however, bubble curtains have been shown to significantly reduce the extent of potential adverse effects.

Proposed Attenuation Methods

Bubble curtains will be used for all impact pile driving on this project. The air bubble attenuation systems are capable of reducing SPLs up to 15 dB (Anchor Environmental, L.L.C. 2004). Based on limited hydroacoustic monitoring data from similar projects (Reyff 2003; Anderson and Reyff 2006), the Service expects that proofing of the sheet piles and impact installation of 260 structural steel piles (24 to 30-in diameter) may result in SPLs up to 211 dB_{peak} and 180 dB_{rms} at a distance of 10 m from the pile. Accounting for an attenuation of at least 10 dB, the Service expects that SPLs will be about 200 dB_{peak} and 190 dB_{rms} within 100 m of the pile driver.

Proposed Marbled Murrelet Monitoring

On December 7, 2006, the Port agreed to conduct marbled murrelet monitoring (Appendix A) in order to minimize potential adverse effects. The protocol requires that a qualified biologist monitors for murrelet presence during impact pile driving operations. If marbled murrelets are identified, the biologist will notify the Construction Contractor, and will track the location of the marbled murrelets. In the event that a marbled murrelet comes within a zone of potential injury, the biologist will immediately notify the Construction Contractor and pile driving will cease until

the murrelet moves out of the area. The monitoring program is intended to protect murrelets from SPLs that could cause injuries.

Effects to Bull Trout from Impact Installation of Steel Piles

Because the enclosed configuration of the boat basin functions like a sound barrier, it is anticipated that sound and pressure levels associated with pile driving conducted within the inner boat basin will not extend very far into Guemes Channel. However, pile driving that is conducted near the outer margins of the boat basin will generate sound pressure levels that will extend across the channel. The attenuation methods proposed by the project proponent will substantially reduce the extent of the potential impacts from pile installation to bull trout, but will not eliminate them entirely. The Service expects that bull trout will be exposed to elevated underwater SPLs from impact pile installation for a period of approximately 25 weeks over the course of two work windows (3 to 4 months a year). These levels could result in mortality, injury, and/or significant alteration of normal behavior.

Effects to Bull Trout from Impact Installation of Steel Piles Expected to Result in Mortality or Injury

The Service uses SPLs measured as peak pressure to define the onset of injury (USFWS 2003b; USFWS 2004a). In 2004, the California Department of Transportation (Caltrans) and the Federal Highway Administration convened a group of experts in the field of underwater acoustics (referred to as the Fisheries Hydroacoustic Working Group) with the intent of evaluating, and potentially refining the criteria. This effort included an extensive literature review which was the basis for report on the topic (Hastings and Popper 2005) and a white paper proposing interim criteria (Popper 2006). The Hastings and Popper (2005) report indicates that a metric of Sound Exposure Level (SEL) may be more appropriate for correlating injury to fishes from pile installation. The basis for this is, in part, because the use of SEL allows for the summing of energy over multiple pile driving pulses, which cannot be accomplished when using peak pressure. Unfortunately, no empirical data are available to develop a method for calculating the accumulation of energy from multiple pile strikes and the resultant effect on fishes. Therefore, the Service continues to use a peak SPL metric to define the onset of expected injury in this analysis.

Based on the preceding information, we anticipate the potential for injury to occur at SPLs greater than or equal to 180 dB_{peak}. The 180 dB_{peak} threshold is conservative because most of the studies described evaluated transmitted signals of longer duration than is anticipated to result from pile driving. Construction will span two in-water work periods and pile driving will be conducted for several months each year. It is anticipated that the pile driver will be operating Monday through Friday during daylight hours for 3 to 4 months each season. The SPL levels associated with vibratory pile driving to install the sheet pile surrounds are not expected cause mortality or injury to bull trout or forage fish. However, proofing of the sheet piles and impact pile driving of the larger diameter steel piles will occur during both work windows. During both impact proofing and impact installation sound pressures are expected to reach levels that can result in injury or mortality.

The action area is not within designated critical habitat for the bull trout. While bull trout have not been documented in the action area, the action area provides marine foraging and migratory habitat and likely is used seasonally by bull trout. There are confirmed reports of bull trout in the marine environment near Rosario Head (Thomas Hooper, NOAA. pers. comm. 2003) on the southwest side of Fidalgo Island and numerous reports of bull trout in the Swinomish Channel (Curt Kraemer, WDFW. pers. comm. 2003b), about 7 miles southeast of the action area. Based on recent telemetry information which indicates that some bull trout may be present in the marine environment any time of the year, it is possible that a few individual adult and sub-adult bull trout may be in the action area during the in-water work period. These subadult and adult bull trout would be exposed to elevated SPLs from impact pile installation for the amount of time they are in the action area. Due to their size, adult fish can likely tolerate higher SPLs (Hubbs and Rechnitzer 1952; Yelverton et al. 1975), and injury rates are expected to be less than those of juvenile fish.

Summary

Based on information from similar projects, the Service evaluated the effects of impact pile driving with the assumption that there will be a 10 dB reduction in peak values with the use of the bubble curtain. As stated above, the Service expects that proofing of the open cell sheet piles and impact installation of 30-in steel piles will result in the highest sound pressures, measuring up to 211 dB_{peak} and 180 dB_{rms} at a distance of 10 m from the pile. Assuming a 10 dB reduction in SPL levels with the use of a bubble curtain, SPLs resulting from pile proofing and installation will be reduced to around 200 dB_{peak}. Using the practical spreading model described above, we have determined that SPLs above 180 dB_{peak} (injury threshold) would occur as far as 100 m from the pile driver. Therefore, all subadult and adult bull trout and forage fish within the 100 m zone are expected to be exposed to injurious SPLs for the duration of impact pile driving. The duration of effects is expected to last approximately 25 weeks and will extend over two work windows (July 15 – January 15), starting in 2007/2008 and continuing to February 2009.

Effects to Bull Trout from Impact Installation of Steel Piles Expected to Result in Significant Disruption of Normal Behavior

As described above, there are significant gaps in scientific understanding of the behavioral effects of impulsive underwater sound on aquatic organisms. The following summarizes those literature sources that the Service feels are most pertinent for anticipating potential effects to bull trout.

Popper (2003) suggests that behavioral response of fishes to loud sounds may include swimming away from the sound source, thereby decreasing potential exposure to the sound, or "freezing" (staying in place), thereby becoming vulnerable to possible injury. Alternatively, responses to sound could affect behavior more extensively and result in the fish leaving a feeding ground (Engas et al. 1996) or an area in which it would normally reproduce or in some other way affect long-term behavior and subsequent survival and reproduction. The effect of these avoidance responses may range from insignificant, to permanent long-term effects if feeding or reproduction is impeded.

Feist and others (1992) found that impact pile driving of concrete piles affected juvenile pink and chum salmon distribution, school size, and schooling behavior. In general, on days when pile driving was not occurring, the fish exhibited a more polarized schooling behavior (moving in a definite pattern). During pile driving, the fish exhibited an active milling schooling behavior (moving in an eddying mass). Fish appeared to change their distributions about the site, orienting and moving towards an acoustically-isolated cove side of the site on pile driving days more than on non-pile driving days.

Knudsen and others (1992) studied spontaneous awareness reactions (consisting of reduced heart beat frequency and opercular movements[3]), and avoidance responses to sound in juvenile Atlantic salmon. This study evaluated the responses of these fish to frequencies ranging from 5 to 150 Hz. With increasing frequencies, the difference between the threshold for spontaneous awareness reaction and the estimated hearing threshold also increased. At 5, 60 and 150 Hz, the signal had to exceed the hearing thresholds by 25, 43 and 73 dB, respectively, to elicit the reactions. Most of the sound energy of impact hammers is concentrated at frequencies between 100 and 800 Hz. Salmonids can detect sounds at frequencies between 10 Hz (Knudsen et al. 1997) and 600 Hz (Mueller et al. 1998), with optimal hearing at frequencies of 150 Hz (Hawkins and Johnstone 1978).

Construction will span two in-water work periods. The aquatic portions of the action area are within marine foraging and migratory habitat for bull trout. Anadromous bull trout use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage (Goetz et al. 2004; Brenkman and Corbett 2005). Use of migratory corridors facilitates gene flow among local populations (USFWS 2004b). Anadromous adult and sub-adult bull trout are expected to use the action area for foraging, and migration during the in-water work period. Subadult and adult bull trout would be exposed to elevated SPLs from impact pile installation for the amount of time they are in the action area.

Summary

Sound pressure levels in excess of 150 dB_{rms} are expected to cause a short-term disruption of foraging and migration behavior in bull trout that may be present in the vicinity of the project during impact pile driving. Using the practical spreading model discussed earlier, we have determined that significant behavioral disruption could occur as far as 1,000 m from the pile driver. Subadult and adult bull trout likely use the action area for foraging, and migrating.

The Service expects that installation of the larger structural steel piles (24 to 30- in diameter) and proofing of the sheet piles will result in SPLs up to 211 dB_{peak} and 180 dB_{rms} at a distance of 10 m from the pile. Assuming a 10 dB reduction in SPL levels with sound attenuation, SPLs will be reduced to 200 dB_{peak} with the use of a bubble curtain. Using 180 dB_{rms} as a source level in applying the practical spreading model, we have determined that SPLs above 150 dB_{rms} will occur as far as 1,000 m from the pile driver and result in significant disruption of normal behavior (Figure 7). The Service anticipates that all subadult and adult bull trout that are within

[3] Knudsen and others (1992) assumed that stimuli that evoke these awareness reactions are adverse to fish.

the 1,000 m zone during impact pile driving will experience a significant alteration of normal behavior and may avoid Guemes Channel, or alter the timing of their migration. The duration of effects from pile driving is expected to last 25 weeks and will extend over two work windows (July 15 – January 15), starting in 2007/2008 and continuing to 2009.

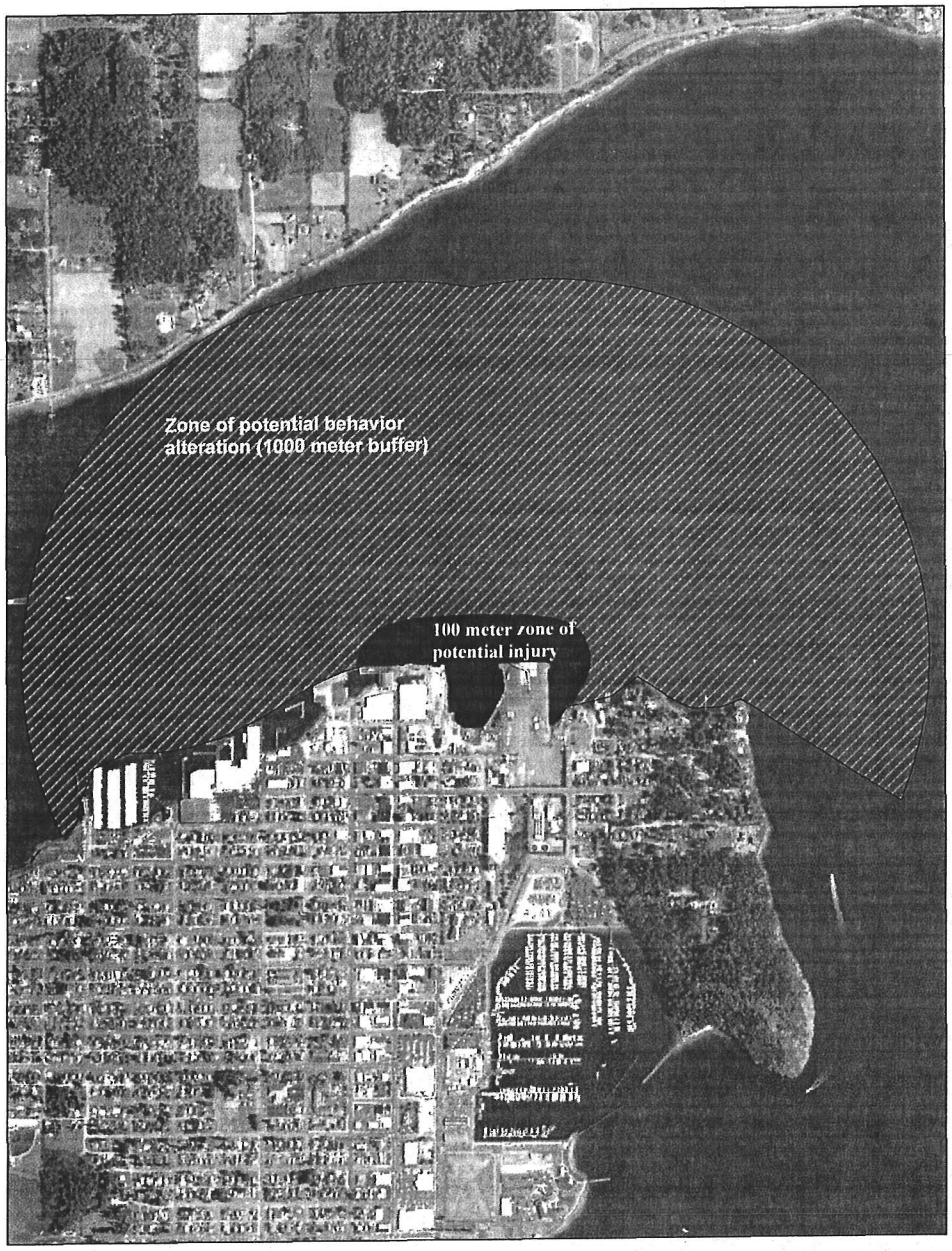

Figure 7: Zone of potential effect from impact pile driving and proofing of sheet piles during the work window.

Effects to Marbled Murrelets from Impact Installation of Steel Piles

The attenuation methods proposed by the Port will substantially reduce the extent of potential impacts from pile installation to marbled murrelets, but will not eliminate them entirely. Similar to bull trout, the Service expects that marbled murrelets will be exposed to elevated underwater SPLs from impact pile installation during construction at levels that could result in injury, and/or significant distruption of normal behavior.

Effects to Marbled Murrelets from Impact Installation of Steel Piles Expected to Result in Injury

As noted earlier, there are significant gaps in scientific understanding of the effects of impulsive underwater sound on aquatic organisms. The following summarizes those literature sources that the Service feels are most pertinent for anticipating potential injurious effects to marbled murrelets.

Experiments using underwater explosives found that rapid change in underwater SPLs resulted in internal hemorrhaging and mortality in submerged mallards *(Anas platyrynchos)* (Yelverton and others 1973). During seismic explorations, it has been noted that seabirds were attracted to fishes killed as a result of the seismic work (Fitch and P.H.Young 1948; Stemp 1985). Fitch and Young (1948) found that diving cormorants were consistently killed by seismic blasts, and pelicans were frequently killed when their heads were below water. Observation of foraging murrelets during impact pile driving at one project in Washington revealed that murrelets will come fairly close (within 300 m) to active pile driving operations and continue to dive and forage despite elevated underwater sound (Entranco, Inc. and Hamer Environmental, L.P. 2005), thus there is a potential for exposure to injurious SPLs.

For fishes, a correlation between size and the impulse level needed to cause injury has been noted (Yelverton et al. 1975; Hastings and Popper 2005). This type of analysis has not been done for birds. However, Yelverton and Richmond (1981) and Yelverton and others (1973) noted mass of the birds used in their studies and gave charge size and range of blasts. The mean mass of the birds used was 1.16 kg for mallards and 2.33 kg for Rouen ducks. Adult marbled murrelets are much smaller, averaging 0.22 kg. Given the correlations observed with size and impulse level, it is likely that marbled murrelets would be impacted by lower impulse levels than those identified for mallards and Rouen ducks.

Adult murrelets go through two periods of molt. The prealternate molt occurs before the breeding season. This is an "incomplete" molt during which the birds lose their body feathers but retain their ability to fly. A complete prebasic molt occurs after the breeding season. During this molt, the birds lose all flight feathers relatively synchronously and are flightless for up to 2 months (Nelson 1997). Timing of molts varies from year to year and from one location to another, as well as amongst individuals. In Washington, prebasic molt is believed to occur from mid-July through the end of August (Chris Thompson, WDFW. pers. comm. 2003). During this time they will be flightless for approximately 2 months and are more susceptible to stress. Since they cannot fly away from potential threats during the molting period, murrelets are likely to

respond to disturbance by diving, which will increase their exposure to elevated underwater SPLs.

Summary

We anticipate the potential for barotrauma to occur in marbled murrelets (when diving) at SPLs of $\geq$ 190 dB_{peak}. Other types of potential physical effects are likely to occur above 180 dB_{peak} based on the studies on both aquatic and terrestrial species discussed above. The 180 dB_{peak} threshold is probably conservative for two reasons: most studies described evaluated transmitted signals of longer duration than what is anticipated to result from pile driving; and marbled murrelets are more adapted to the underwater environment than the humans and other terrestrial species used in many of the studies. Using the practical spreading model described above, we have determined that SPLs above 180 dB_{peak} would occur as far as 100 m from the pile driver. Implementation of a murrelet monitoring protocol (Appendix A) will significantly reduce the risk of injury or harm to murrelets within the 100 m zone.

Effects to Marbled Murrelets from Impact Installation of Steel Piles Expected to Result in Significant Alteration of Normal Behavior

Behavioral response of seabirds, including marbled murrelets, was monitored during construction of the Hood Canal Floating Bridge Replacement project in Washington (Entranco and Hamer Environmental 2005). Observers noted that at the beginning of the pile driving work the majority of seabirds in the vicinity responded by flushing, but that this response lessened over time, indicating that there was some habituation. Their observations also noted that, despite ongoing construction disturbance, murrelets came within close proximity of the project and continued to dive and forage.

Behaviors that we believe would indicate disturbance of murrelets in the marine environment include: aborted feeding attempts; multiple delayed feeding attempts within a single day, or across multiple days; multiple interrupted resting attempts; and precluding access to suitable foraging habitat. These behaviors could result in an increased risk of predation and reduced fitness in adults, the outcome of which could constitute injury. With the exception of interrupting resting attempts, exposure to elevated SPLs underwater could result in all of the above behaviors for the duration of pile driving associated with this project.

Summary

We anticipate disruption of foraging and resting murrelets during the duration of impact pile driving and proofing. This disruption could lead to decreased foraging attempts or decreased foraging efficiency which could lead to increased energetic costs to murrelets. The Service expects that proofing of the open cell sheet piles and impact installation of the structural steel piles (24 to 30- in diameter) will result in the highest sound pressures, measuring up to 211 dB_{peak} and 180 dB_{rms} at a distance of 10 m from the pile. Assuming a 10 dB reduction in SPL levels with the use of a bubble curtain, SPLs will be approximately 200 dB_{peak}. Using the practical spreading model, we have determined that SPLs above 150 dB_{rms} will occur as far as

1,000 m from the pile driver and result in significant disruption of normal behaviors. All marbled murrelets within the 1,000 m zone will be exposed to SPLs that are likely to result in significant alteration of normal behavior during impact pile driving. Impact pile driving is expected to take 25 weeks and will be conducted over the course of two work windows (July 15 to February 15), starting in July 2007 and ending in February 2009.

Effects of Vibratory Installation of Sheet Piles

Vibratory hammers produce underwater peak pressures that are approximately 17 dB lower than those generated by impact hammers (Nedwell and Edwards 2002). Not only are these sounds different in intensity, but also in frequency and impulse energy (total energy content of the pressure wave) which may account for the fact that no fish kills have been associated with use of vibratory hammers. Most of the sound energy of impact hammers is concentrated between 100 and 800 Hz, the frequencies thought to be most harmful to aquatic animals, while the sound energy from the vibratory hammer is concentrated around 20 to 30 Hz. 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; Nedwell and Edwards 2002).

Just as these two sounds are different, so are the observed behavioral responses of fishes to them. Most of the energy in the sounds produced by vibratory hammers is at around 20 to 30 Hz, near the range of infrasound (less than 20 Hz). Fish have been shown to avoid infrasound (Knudsen et al. 1997). However, depending on the location of the vibratory installation, sound pressure levels may not exceed ambient sound levels. Vibratory installation of steel piles in a river in California resulted in sound pressure levels that were not measurable above the background sound created by the current (Reyff 2006). Noise measurements of vibratory pile driving taken at the Friday Harbor terminal recorded L_{eq} readings of 86.4 dBA at 85 ft (WSDOT 1994).

In conclusion, the Service does not anticipate adverse effects to bull trout or marbled murrelets in the form of physical injury, mortality, or behavioral disruption from vibratory installation of sheet piles based on the differences, discussed above, in the underwater sounds produced by vibratory driving of piles.

Effect of In Air Noise to Marbled Murrelets from Impact Pile Driving

We estimated the injury threshold for above water sound by using data for sound-induced flushes in birds. These data were from Thiessen and Shaw (1957), Awbrey and Bowles (1990), Brown (1990), and Delaney et al.(1999). Thiessen and Shaw (1957) found that caged ring-billed gulls (*Larus delawarensis*) subjected to sounds at a range of frequencies and decibel levels reacted by cringing at 83-91 dB at 150 cps (cycles per second = Hertz) and by increased heart rates at 92 dB; it is unknown at what dB level these birds would have flushed. Awbrey and Bowles (1990) stated that "what little published literature is available suggests that noise begins to disturb most birds at around 80-85 dB sound levels and that the threshold for the flight response is around 95 dB." Brown (1990) subjected crested terns to experimental sounds imitating aircraft overflights in an area with 55-75 dB ambient sound levels, and found that, at 70 dB, about 55 percent were alert and, at 95 dB (the loudest they tested), approximately 15 percent were startled and 8 percent

flushed. Using the results from these studies, we estimate the in-air flushing threshold to be 92-95 dB.

The maximum sound levels (in air) for a variety of equipment are: 1) piston helicopters - range 73-86 dB at 500 ft and turbine helicopters - range 65-78 dB at 500 ft, 2) single-engine propeller airplanes - range 67-77 dB at approach at 1,000 ft, 3) impact pile drivers - peak 106 dB, 4) jackhammers and rock drills - range 82-97 dB, and 5) heavy equipment - range 72-96 dB (Canter 1977).

In evaluating the effects of sound-related disturbance, we determined that murrelets could be adversely affected by sounds at or above 92 dB ("Response/injury Threshold"), sounds that are more than 20 dBA above the background ambient ("Above-ambient Threshold") and/or sounds representing a 9 or 15 dbA difference between all existing sound and the action-generated sound ("Action-Generated Threshold") (USFWS 2002d). Assuming regular use of heavy equipment, boat lifts, welding and metal cutting machines, and other sound-generating equipment typical of industrial ports and shipyards, we estimated the ambient background sound levels at the project site to be around 70 to 75 dB. Based on the assumption that murrelets that forage in the vicinity are habituated to elevated sound levels, we anticipate the avoidance threshold to be 20 dBA above background, or approximately 92 dB. Using the sound spreading calculator for in-air sounds (6dB reduction per doubling distance for open sites) and a peak of 106dB at the hammer, sound levels will drop to 92dB at approximately 300 ft (100 m) and 70dB at a distance of approximately 1,000 m.

High sound levels generated by impact pile driving could mask vocalizations between murrelets. Murrelets tend to be more vocal at sea compared to other alcids (Nelson 1997). Individuals of a pair vocalize after surfacing apart from each other (Strachan et al. 1995). Vocalizations among pairs also occur after a disturbance (Strachan et al. 1995). When pairs are separated by boats, they often will call to each other and attempt to reunite (Strachan et al. 1995). Strachan and others (1995) 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). Assuming that vocalization plays a role in a cooperative feeding, interruption of vocal communication could affect foraging efficiency. Similarly, at-sea courtship is likely to be negatively impacted. Courtship begins in early spring, continues through summer, and has also been noted in winter (Nelson 1997; Speckman et al. 2000).

Summary

Because of the relatively high ambient sound levels at the project site, we do not anticipate the in-air sound of vibratory pile driving to exceed 92dB. However, the sound generated by impact pile driving could disrupt foraging and mask vocalizations by marbled murrelets, potentially resulting in reduced foraging efficiency. The Port has agreed to a monitoring protocol that will significantly reduce the likelihood of marbled murrelets being within 100 m of the pile driver during impact pile driving. Because marbled murrelets will not be exposed to sound levels above 92dB, the Service does not anticipate them to be harmed from the in-air sound of impact pile

driving, elevated sound levels may cause normal vocalizations and foraging activities to be interrupted up to 1,000 m of the pile driver. All marbled murrelets within the 1,000 m zone will be exposed to in-air sound levels that are likely to result in significant alteration of normal behavior during impact pile driving. Impact pile driving is expected to take 25 weeks and will be conducted over the course of two work windows (July 15 to February 15), starting in July 2007 and ending in February 2009.

New Overwater Structures

Effects of Increased Shading from Overwater Structures and Construction of the Bulkhead

Construction of the new piers will add about 18,200^2 of overwater shade to the action area. As designed, the new structures will shade the same amount of intertidal and shallow subtidal habitat as the existing piers do. All increases of overwater shading will occur in the deeper portions of the ship basin beyond the photic zone.

Limited information is available regarding the use and movement of bull trout under overwater structures. One radio-tagged bull trout was detected adjacent to an approximately 40-foot wide dock at Kayak Point in Puget Sound (Fred Goetz, USCOE. Pers. comm. 2005). Data from a hydrophone at that location indicated the bull trout appeared to move under the dock rather than around it. Heiser and Finn (1970) first documented a reluctance of juvenile salmonids to pass under docks. Since that time, more ambiguous results have been reported with some individuals passing under the dock, some pausing and going around the dock, schools breaking up upon encountering docks, and some pausing and eventually going under the dock (Pentec 1997; Nightingale and Simestad 2001). Recent monitoring of juvenile Chinook salmon tagged with acoustic transmitters in Lake Washington and the Lake Washington Ship Canal has shown that they are often reluctant to pass under overwater structures, especially large structures (City of Seattle 2000). However, during construction monitoring at the Hood Canal Bridge Replacement project, two schools of juvenile salmonids [species unconfirmed, but probably chum (*Oncorhynchus keta*)] were observed passing without hesitation under a temporary work trestle (Southhard et al. 2006). The observation occurred on a sunny day when there were distinct shadows on the water's surface.

Although it is difficult to extrapolate from these site-specific observations, they illustrate the high degree of variability in fish response to structures that may be based on factors such as species, age classes, habitat types, seasonal timing, and structure design. The observation at Kayak Point indicates that bull trout movement may not be significantly affected by overwater structures. Additionally, bull trout are generally not considered to be as strongly tied to the nearshore as other salmonids. Another factor to consider is that the industrial waterfront currently contains multiple overwater structures. As such, the Service does not expect replacement of the piers to affect bull trout movement through the action area.

Overwater structures and bank armoring can also affect the ecological functions of nearshore habitat and interfere with habitat processes that support the key ecological functions of forage fish habitat. Alterations include reduced light intensity, alteration of substrate and sediment

transport regimes, reduction in epibenthic prey and forage fish, loss of coarse woody debris, loss and/or fragmentation of aquatic vegetation, simplification of nearshore habitat, modification of wave energy and hydraulics, altered light regimes, and a reduction in water quality (Simenstad et al. 1999; Carrasquero 2001; Nightengale and Simenstad 2001; Haas et al. 2002; Kelty and Bliven 2003; Scheuerell and Schindler 2004). The large number of docks and piers along industrial waterfronts influence wave patterns and sediment composition and the need to accommodate access for commercial and deep draft vessels often results in permanent loss of intertidal habitat.

Summary

Most of the shallow intertidal habitat will be converted to deep water during dredging. To compensate for the loss of shallow water habitat in the boat basin, an equal amount of intertidal habitat will be restored or created at the mitigation sites (see dredging section).

Construction of the sheet pile surround will prevent sloughing of the banks and reduce the need for maintenance dredging within the boat basin. Because the bulkhead is designed to prevent bank erosion, it will have long-term effects on recruitment of substrate material. However, since the boat basin is a confined area and is already being used as a commercial shipyard, adding 670 linear ft of bank protection along the inner edges of the boat basin is not expected to affect nearshore habitat within Guemes Channel. The new piers will be situated over deep water. No impacts to aquatic vegetation as a result of increased overwater shading are anticipated.

The Service has determined that replacement of the piers and installation of the sheet pile surround will not affect bull trout movement through the action area and will not have a measurable affect on the abundance and distribution of bull trout prey resources. Thus, effects to bull trout and their prey resources from this phase of the construction are considered insignificant.

Effects of Additional Overwater Structures on Marbled Murrelets

Marbled murrelets use nearshore areas to forage. As mentioned earlier, they are not likely to forage within the boat basin or in close proximity to the shipyard. Replacement of the piers and additional overwater shading is not expected to alter murrelet use of the action area. Because marbled murrelets are not expected to utilize the immediate project area for foraging, and because the existing baseline includes a substantial amount of existing over-water structure, any effects from the proposed addition of structures in this location are expected to be insignificant.

Stormwater Runoff and Onshore Infrastructure

According to the National Pollution Discharge Elimination Permit (NPDES permit, WA-003141-1, issued on May 19, 2006), the DCI shipyard is not allowed to discharge any chemicals, oils, or contaminants into waters of the state. All stormwater, wastewater, and chemical residues from the shipyard and new impervious surfaces will be collected and transferred to the wastewater treatment plant in Anacortes. The project will also require a construction stormwater general permit from the Department of Ecology.

The City of Anacortes is the only city in Skagit County with a storm sewer system that services commercial and industrial facilities, including the Port and DCI shipyard. The wastewater treatment plant was updated in 1992 and is designed for an average capacity of 2 million gallons a day. A voluntary cleanup action under the Model Toxics Control Act has been completed by the Port for previously identified area of contaminants within the shipyard. Existing water, sanitary sewer, and electrical systems within the shipyard will be upgraded as part of the proposed action. New catch basins and storm conveyance systems will be installed throughout the shipyard and the existing municipal combined sewer overflow structure will be repaired.

As pollutant levels are expected to be reduced, and because there is no surface water connection to the discharge area, the Service does not expect bull trout or marbled murrelets to be exposed to potential contaminants from stormwater runoff. As such, the effects of stormwater runoff from the proposed project are considered discountable.

Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur (50 CFR 402.02). Indirect effects may occur outside the area directly affected by the action. No indirect effects related to the proposed project have been identified and the Service does not expect any indirect effects as a result of the proposed project.

Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions have no independent utility apart from the action under consideration.

The proposed project is not part of a larger action, and does not depend on a larger action for its justification. Therefore, the Service has not identified any interrelated or interdependent actions related to the propose project.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. These include, but are not limited to, a variety of Port, marina, and dredging projects that are in the planning or permitting stage (City of Anacortes 2007). Many of these projects have in-water components that will require state and Federal permits. Other private actions that will have in-water components are assumed to require Federal permits through the Clean Water Act or Section 10 of the Rivers and Harbors Act of 1899.

The City of Anacortes is widely viewed as an extremely desirable place to live and work, which is reflected in the real estate prices. Every 7 years the Growth Management Act (GMA) (36.70A RCW) requires Skagit County to update its comprehensive plan and development regulations to ensure compliance with the GMA. According to the City of Anacortes 2007 Comprehensive Plan, the current population of 16,000 residents is expected to increase to 19,300 within a few years. The economy has strong ties to fishing and tourism and is reliant on a burgeoning boat building and marine service sector. Manufacturing and shipping, which includes the DCI shipyard, currently supports 37 percent of the employment market and accounts for 43 percent of the city zoning acreage (City of Anacortes 2007). Continued development and conversion of undeveloped lands in the City will result in an increased amount of impervious surface and associated stormwater runoff. Private boat use in Rosario Strait and Guemes Channel is anticipated to increase as the population grows. The cumulative effects of increased development and water-related recreation will have long-term effects on water quality. Thus, bull trout and marbled murrelets may be affected by increased exposure to contaminants from stormwater runoff and degraded water quality in the long-term.

The industrial waterfront of the action area is zoned manufacturing/shipping (MS) and manufacturing/shipping (MS) with the surrounding uplands zoned as light manufacturing (LM), central business district (CBD), commercial/marine (CM), and low to medium density residential (City of Anacortes 2006). The marine portion of the action area includes Guemes Channel, Fidalgo Bay, and Guemes Island. Guemes Island is designated as rural, low density (Skagit County 2003). The Guemes Island 1975 Shoreline Master Plan is in the process of being updated and is likely to provide increased protection of its shoreline.

The purpose and need of upgrading and improving the Port facility is to accommodate larger vessels and ensure that the DCI shipyard remains competitive in today's market. As a major employer in the community, the Service expects that upgrading the Port facilities (Pier I) and increasing the capacity of the DCI shipyard will have growth inducing effects within the City of Anacortes and surrounding waters. Although the proposed upgrades are not expected to result in increased vessel traffic at the DCI shipyard, it will allow the shipyard to accommodate larger vessels and diversify production, which in turn will maintain stable employment in the community. Dredging the boat basin will provide berthing capacity where none currently exists and will free up the outer piers for other marine uses and vessel moorage. Upland improvements include construction of a lateral rail transfer system, parking lot improvements, and a new vehicle entrance off the end of R Avenue. This will result in approximately 90 percent of the uplands being converted to impervious surfaces.

The GMA requires the Port to provide recreational opportunities along the waterfront and the Pier I upgrades will provide pedestrian access to the beach, interpretive signs, parking, and viewpoints at the mitigation sites. The mitigation sites are designed to offset the impacts to shallow-water areas in the boat basin and restore intertidal habitat for salmonids and forage fish. Providing public access to the beach may reduce the habitat value of these areas.

Future State and private actions within the action area may result in disturbance of shoreline and aquatic habitat areas. Future development in the City of Anacortes will need to comply with the

City of Anacortes' Comprehensive Plan, including critical areas ordinances, and the Shoreline Master Program. The Urban designation allows for mixed use of residential and commercial activities. The conservancy designation is primarily for recreational use and preservation of open space (City of Anacortes 2006). Future development on Guemes Island will need to comply with Skagit County's critical areas ordinances and the Shoreline Master Program. The GMA goals include reducing urban sprawl, protecting the environment and water quality, and increasing tourism, marine, and water-related recreational activities. The goals for areas that are zoned commercial and manufacturing include encouraging marina and boating related businesses, providing public access to shoreline areas, and encouraging City and Port operations that provide transient moorage and moorage for moderate size cruise ships. Increasing berthing areas within the DCI shipyard will free up moorage at the Port facilities, thus allowing for increased vessel use in the area.

The Service expects that the cumulative effects of activities in the action area may have long-term effects on water quality in Rosario Strait, Bellingham, and Guemes Channel. However, with the City's comprehensive stormwater treatment system and implementation of the critical area ordinances to protect water quality and marine habitats, we anticipate these impacts to be negligible. Non-Federal activities in the marine portion of the action area would likely be limited to an increase in recreational boat traffic. Thus, the Service expects that cumulative effects within the action area will not be measurable and are therefore considered insignificant.

CONCLUSION

The implementing regulations for section 7 of the Act at 50 CFR §402 define "jeopardize the continued existence of" as "an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, and distribution of that species."

Bull Trout

After reviewing the current status of the bull trout, the environmental baseline for the action area, the effects of the proposed project, and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout within its coterminous range for the following reasons:

- Impacts to bull trout resulting from the proposed project will be short-term (during construction) and localized to the boat basin. The boat basin does not currently provide good habitat for bull trout or forage fish and the proposed action will not result in a measurable change in the baseline condition.

- The in-water work period represents the time of year when bull trout are least likely to be in the marine environment. As a result, we anticipate that very few individuals will be affected by the proposed action.

- Effects of the action are short term and will not preclude bull trout from using the area for foraging and migration.

- Individuals from 4 of 8 core areas in the Puget Sound Management Unit could be affected by the proposed action. Distribution of these effects to a small number of individuals across four core areas is not expected to appreciably reduce the distribution, reproduction, and number of bull trout within the coterminous range.

Marbled Murrelet

After reviewing the current status of the marbled murrelet, the environmental baseline for the action area, the effects of the proposed project, and the cumulative effects, it is our biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of the marbled murrelet in its listed range for the following reasons:

- No mortality of marbled murrelets from pile driving, dredging, or other construction activities is expected.

- The population in Zone 1 (Puget Sound) is relatively large compared to other recovery zones, and only a small proportion of the marbled murrelets and a small area of Zone 1 will be affected by the proposed action. These effects are not expected to reduce numbers, reproduction, and distribution of marbled murrelets in Zone 1.

- The primary threats to marbled murrelets in Zone 1 are habitat loss, predation, and mortality in the marine environment from oil spills and commercial fisheries. The proposed action will not result in habitat loss or increased predation, and is not expected to cause mortality.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. *Harm* in the definition of "take" in the Act means an act which actually kills or injures wildlife. Such 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* in the definition of "take" in the Act means 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 Act 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 U.S. Army Corps of Engineers so that they become binding conditions of any grant or permit issued to the Port, as appropriate, for the exemption in section 7(o)(2) to apply. The U.S. Army Corps of Engineers has a continuing duty to regulate the activity covered by this incidental take statement. If the U.S. Army Corps of Engineers (1) fails to assume and implement the terms and conditions or (2) fails to require the Port 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 Port, 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

Bull Trout

The Service anticipates that the following forms of incidental take will occur as a result of the activities associated with the project:

Incidental take of bull trout in the form of ***harm*** through physical injury from the direct effects of elevated underwater SPLs resulting from impact pile driving of larger diameter steel piles and proofing of sheet piles between mid-July and mid-February 2007-2009. Incidental take of a small number of bull trout is also anticipated from the 10-year fish monitoring program at the mitigation sites.

- All sub-adult and adult bull trout within approximately 100 m of large diameter steel piles that are being proofed or installed using an impact hammer, are expected to be incidentally ***harmed.*** The 100 m zone represents an area about 8 acres in size.
- Incidental capture and handling of adult and sub-adult bull trout during fish sampling (seining) efforts at the mitigation sites over the ten year fish sampling period may result in ***harm*** to no more than 2 individual bull trout per year (total of 20 bull trout). Although all fish that are caught will be released, individuals that are captured may be injured and/or stressed.

Incidental take of bull trout in the form of ***harassment*** through significant disruption of normal foraging and migratory behavior resulting from elevated underwater sound pressure levels generated by proofing and/or impact pile driving of steel piles between mid-July and mid-February 2007-2009.

- All bull trout within 1,000 m of impact pile driving are expected to be ***harassed*** during impact pile driving between mid-July and mid-February 2007-2009. The total area affected in the form of harassment is approximately 576 acres.

Marbled Murrelet

We anticipate incidental take of marbled murrelets from the population inhabiting Conservation Zone 1 to result from the project as follows:

Incidental take of marbled murrelets in the form of ***harassment*** through significant disruption of normal foraging and resting behavior resulting from impact pile driving between mid-July and mid-February 2007-2009.

- All marbled murrelets foraging within 1,000 m of impact pile installation and proofing are expected to be ***harassed*** during impact pile driving between mid-July and mid-February 2007-2009. The total area affected in the form of harassment is expected to equal approximately 576 acres.

The Service will not refer the incidental take of any migratory bird or bald eagle for prosecution under the Migratory Bird Treaty Act of 1918, as amended (U.S.C. §§ 703-712), or the Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. §§ 668-668d), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

EFFECT OF THE TAKE

In the accompanying Biological Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the bull trout or the marbled murrelet.

REASONABLE AND PRUDENT MEASURES

The following reasonable and prudent measure(s) are necessary and appropriate to minimize take of the bull trout:

BTI. Minimize the likelihood of harm of bull trout within the action area during construction.

The following reasonable and prudent measure(s) are necessary and appropriate to minimize the impact of take on the marbled murrelet:

MMI. Minimize harassment of marbled murrelets within the action area during construction.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the U.S. Army Corps of Engineers 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.

Bull Trout

Terms and Conditions applicable to RPM - BT1:

1. Use a vibratory pile driver for installation of all piles. Limit the use of impact hammers only for final proofing of load-bearing piles or installation of individual piles in areas where vibratory pile driving will not work.
2. Water quality measurements shall be taken during dredging activities to ensure compliance with the state water quality standards.

Marbled Murrelet

Terms and Conditions applicable to RPM - MM1:

1. "Dry fire" the pile driver once or twice before conducting impact pile driving to alert any murrelets that may be within a few hundred meters of the pier and encourage them to move farther away.

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

CONSERVATION RECOMMENDATIONS

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

We recommend the following additional actions to promote the recovery of federally listed species and their habitats:

1. Limit the use of impact pile drivers as much as possible between July 15 to August 15 to reduce the risk of disturbance to marbled murrelets during the molt and minimize impacts to bull trout that may still be in the marine environment.

2. Maintain a spill response kit and personnel trained in its use on site at all times to minimize potential impacts from accidental spills or leaks.

3. To further minimize potential contamination from creosote-treated timber, cut broken pilings that could not be removed intact below the mudline and cap the disturbed area with clean sand.

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

REINITIATION NOTICE

This concludes formal consultation on the action(s) outlined in the reinitiation 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.

If you have any questions regarding this Biological Opinion, please contact Martha Jensen (360-753-9000) of my staff at the letterhead phone/address.

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