Endangered Species Act – Section 7 Formal Consultation

Biological Opinion

State of Washington Low-Effect Commercial Geoduck Fishery Habitat Conservation Plan

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Agency:

U.S. Fish and Wildlife Service
Region 1
Portland, Oregon

Consultation Conducted by:

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

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Ken S. Berg

Ken S. Berg, Manager
Washington Fish and Wildlife Office

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Date

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INTRODUCTION

This document constitutes the U.S. Fish and Wildlife Service's (FWS) Biological and Conference Opinion (Opinion) regarding the FWS's issuance of an incidental take permit (Permit) to the State of Washington Department of Natural Resources (WDNR) for their Commercial Geoduck Fishery Low-Effect Habitat Conservation Plan (Geoduck HCP) and its effects on the threatened bull trout (*Salvelinus confluentus*), threatened marbled murrelet (*Brachyramphus marmoratus*), endangered California brown pelican *(Pelecanus occidentalis*); 3 unlisted species, tufted puffin (*Fratercula cirrhata*), coastal cutthroat trout (*Oncorhynchus clarki clarki*) and the bald eagle (*Haliaeetus leucocephalus*), and on critical habitat for bull trout. The 3 unlisted species are included should they become listed during the term of the Permit. This document is prepared in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.; ESA).

This Opinion is based primarily on information provided in the WDNR's Geoduck HCP (WDNR 2008), which is incorporated by reference, and the sources cited herein. A complete record of this consultation is on file at the FWS's Western Washington Fish and Wildlife Office.

BACKGROUND

In 1967, the agency that is now the Washington Department of Fish and Wildlife (WDFW) began conducting subtidal surveys to determine if the geoduck clam (*Panopea abrupta*) resource could support commercial harvest. The geoduck resource of Puget Sound and the Strait of Juan de Fuca was found to have sufficient biomass to support a commercial fishery. In l969, WDNR and WDFW jointly petitioned the Washington State Legislature to open a commercial geoduck fishery. The Legislature created a statute to control harvest, and directed WDNR and WDFW to manage the fishery cooperatively.

A December 20, 1994, U.S. District Court decision by Judge Edward Rafeedie affirmed and quantified the Puget Sound Treaty Indian Tribes' (Tribes) right to 50 percent of the harvestable surplus of geoducks within their usual and accustomed fishing grounds and stations. A subsequent Federal district court order and judgment confirmed the Tribes' management role of geoduck clams. The state agencies and the Tribes are jointly responsible for estimating population size, determining sustainable yield, and ensuring that adverse effects to the environment are kept to a minimum.

The WDNR has proprietary rights over the state's harvest opportunity on half of the harvestable geoducks and offers the right to harvest specific quantities in specific areas to private companies and individuals. Only the above specified harvest will be covered by the Geoduck HCP. The terms of harvest are stipulated in a harvesting agreement, which is a legally binding contract between the State and each private harvest company that participates in the fishery. The WDNR marks the tracts, appraises the resource value, schedules and supervises an on-site harvest, conducts public auctions of geoduck resources, maps and surveys tracts, and enforces contract provisions and state laws regarding geoduck harvest. WDNR enters into a biennial contract with WDFW to partially fund activities for managing geoduck resources.

The WDFW performs biological stock assessments of the commercial geoduck resource, calculates and recommends the annual total allowable catch for each geoduck management region, conducts geoduck related research, and monitors the effects of harvest on the geoduck resource, the substrate, and the associated flora and fauna.

Although each state agency has separate and distinct responsibilities, WDNR and WDFW share enforcement responsibility for Washington State laws, regulations, and harvesting agreement conditions as appropriate within the responsibilities and mandates of each agency. For example, WDNR is responsible for on-tract compliance of geoduck harvest and WDFW is responsible for general off-tract enforcement (e.g., poaching curtailment).

CONSULTATION HISTORY

The WDNR developed the Geoduck HCP in response to the Federal listings of certain fish and wildlife species under the Endangered Species Act. The Geoduck HCP covers only the geoduck fishery activities that are administered and managed by WDNR.

Since 2005 WDNR has worked with the FWS and the National Marine Fisheries Service (NMFS) (together know as the Services) to develop an HCP under section 10(a)(1)(B) of the Act. The WDNR submitted a formal application to the Services for Permits on August 15, 2007. On September 14, 2007 (72 FR 52575 - 52576), a draft of the Geoduck HCP was released for a 30-day public comment period, along with a Draft Environmental Action Statement. The Services believed that approval of the Geoduck HCP would qualify for a categorical exclusion under the National Environmental Policy Act (NEPA), of 1969, as amended, as provided by the Departmental Manual (516 DM2 Appendix 1 and 516 DM 6 Appendix 1), and as a “low-effect” plan as defined by the Habitat Conservation Planning Handbook (FWS and NMFS 1998). The Services determine whether an HCP is low-effect based upon whether the HCP has minor or negligible effects on federally listed, proposed, or candidate species and their habitats and minor or negligible effects on other environmental values or resources; that together with the impacts of other past, present, and reasonably foreseeable similarly situated projects would not result, over time, in cumulative effects to the environmental values or resources which would be considered significant. The Services found the Geoduck HCP to qualify as a low-effect HCP; therefore, further NEPA documentation is not required. The comment period began on September 14, 2007, and closed on October 15, 2007.

Formal consultation on the proposed action considered herein was initiated on October 9, 2007. A Federal Fish and Wildlife Permit Application Form was hand delivered to the Western Washington Fish and Wildlife Office on the aforementioned date. The final Geoduck HCP was submitted by the WDNR to the Services on July 29, 2008. This Opinion analyzes the effects to covered species under the jurisdiction of the FWS in the proposed action area. The NMFS is also conducting formal consultation on the proposed action on anadromous salmonids and several other marine species that are under their jurisdiction.

BIOLOGICAL OPINION

This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

1.0 DESCRIPTION OF THE PROPOSED ACTION

The commercial geoduck harvest began in Washington State in 1970, but at that time the market demand was limited. Demand grew significantly, however, with the establishment of a major new market in Japan. Geoduck harvest has been occurring for over 35 years, and has been occurring at about the same levels since the late 1990's. The fishery is managed using a sustainable harvest rate model and it is expected to continue in the future at a similar harvest level.

1.1 Project Description, Harvest Area Totals, and Harvest Frequency

To harvest geoducks, commercial divers use water-jets to loosen the substrate immediately around the clam, which allows removal by hand. The water-jet is a nozzle about 18 inches long with a 5/8-inch diameter tip at the digging end and a shut-off valve on the other. After the diver locates the clam by its "show" (siphon extended out of the substrate) or by feeling for the depressions it leaves in the substrate, the nozzle is inserted next to the exposed geoduck siphon, or in the hole which is left when the siphon is retracted. A short burst of water, with a pressure of 40 to 60 pounds per square inch, loosens the sediment, allowing individual geoducks to be easily removed. A diver using this method can often harvest 1,500 pounds per day (approximately 800 clams) on a good tract.

Divers operate from anchored boats. Commercial geoduck harvest under the proposed Geoduck HCP occurs between the depths of -18 ft mean lower low water (MLLW) and -70 ft d MLLW, because this is the limit at which divers can most efficiently harvest the resource using compressed air SCUBA and the Navy dive table. Geoducks occur across a broader range, both deeper and shallower, than the current commercial tract depth limits. Pumps and compressors on the boats provide divers with air to breathe through hoses that are up to 400 feet long as well as pressurized water for the water-jet nozzle. Boats may have one or two harvest divers in the water at a time. A tender works on board the harvest vessel to monitor pumps and compressors and to haul harvested geoducks aboard. The tender and divers are in constant contact via an underwater communication system.

1.2 Disturbance duration and frequency

WDNR is requesting an incidental take permit for 50 years for commercial geoduck harvest. Harvest areas are rotated within regions according to harvest agreements between the State and Tribes. Commercial harvest is managed so that it occurs within one management region at a time, and usually on one to three tracts at a time. Harvest is allowed Monday through Friday, from 8:00 a.m. to 4:30 p.m. and does not occur on State holidays or weekends. The proposed HCP limits harvest of geoduck tracts from all six Geoduck Management Regions to a combined maximum of 6,000 acres per year, with only 1,500 acres per year being harvested from any one Management Region. Based on data from 2001 to 2005 harvest years (WDNR 2008), harvest

typically occurs on 8 to 11 tracts per year. Acres harvested ranges from 1,732 to 2,380 acres over the same period. Actual area of sea floor disturbed due to harvest activities on those tracts averaged 254 with a range from 171 to 292 acres per year. Dividing the actual area of sea floor disturbed by harvest activities (1,288 acres) over the 5 years by the cumulative tract size (9,318 acres) over the same five year period, yields a percent of seafloor disturbed of 13.6. The range is 9 to 19 percent. Multiplying 13.6 percent by the harvest limits in the HCP (6,000 acres and 1,500 acres), it is estimated that an average of 816 acres total (range 540 to 1,140 acres over 6 Management Regions) and 204 acres per management region (range 135 to 285 acres per one Management Region) of sea floor will be disturbed by harvest activities annually over the term of the permit. This will result in an overall maximum total average of 40,800 acres (range 27,000 to 57,000 acres over 6 Management Regions) and 10,200 acres per management region (range 6,750 to 14,250 acres per one Management Region) for the 50-year permit period. These acreage calculations could vary over time if the density of geoducks increases or decreases significantly over the term of the proposed HCP. Using 250 harvest days per year and the range of 540 to 1,140 for acres of seafloor disturbed by harvest activities annually, we estimate that approximately 2.16 to 4.56 acres of seafloor are disturbed during an average day's harvest.

1.3 Conservation Measures

Nearshore buffers – WDNR will protect nearshore habitats from geoduck harvest activities by locating the closest shoreward harvest boundary at or deeper than the -18 feet MLLW water depth contour. This is intended to protect nearshore habitats where younger juvenile salmonids and forage species are generally found and where the majority of forage fish species spawn. It also prevents disturbance of migrating adult salmonids.

Eelgrass buffers – WDNR will avoid and protect eelgrass by establishing a 2-foot vertical or 180-foot horizontal (on very gradual slopes) buffer between geoduck tracts adjacent to eelgrass beds and the deepest occurrence of eelgrass. This will protect eelgrass habitat used for refuge by the covered fish species, and will protect eelgrass habitat used for spawning and refuge by forage fish species important as prey to the covered species.

Herring spawning area buffer – WDNR will protect herring spawning habitat and macroalgae habitat that may provide cover for other fish, and avoid disturbing herring during spawning times by establishing shoreward harvest boundaries. On tracts adjacent to documented herring spawning areas (eelgrass, macroalgae, or other substrate), the shoreward harvest boundary will be restricted to waters deeper than –35 feet MLLW during spawning season and deeper than –25 feet during the remainder of the year.

Within one year after obtaining the Incidental Take Permits, WDNR will contact appropriate WDFW and Tribal biologists and arrange a meeting for the purposes of assessing and reaffirming that the above buffers are adequate to protect nearshore environments, eelgrass, and herring spawning areas.

Diver recall system – WDNR will avoid potential interactions between orcas, people, and harvest activities by invoking the "diver recall" system to get divers out of the water when orcas are sighted near the tract being harvested. WDNR divers and harvesters will remain out of the water, and vessel engines will be turned off and will remain off until all orcas have left the area.

Noise restrictions – WDNR will reduce the likelihood of disturbing species vulnerable to surface noise disruptions by limiting surface vessel noise to 50 decibels or less at a distance of 200 yards (600 feet) from each vessel. Harvesting agreements require vessels to operate at surface noise levels less than 50 decibels measured at 200 yards (600 feet) from the source; a level less than the current state standard.

1.4 Fuel Spill Risk Management Strategy

- Fuel spills and similar risks will be managed by WDNR compliance staff in cooperation with harvesters.
- Harvest vessels in danger of capsizing, or with obvious leaks of toxic or hazardous materials will be required to stay out of the harvest area and return to the docks for necessary repairs before they can return to the harvest tract.
- The harvesting agreement will require purchasers and their subcontractors to comply with all Federal, State, and local laws and regulations concerning the use and disposal of hazardous, toxic, or harmful substances.
- Harvesters will be required to notify WDNR of any release of hazardous, toxic, or harmful substances.
- Harvest vessels will carry pollution liability insurance to provide funds in the event of a spill.
- A Vessel Spill Contingency Plan will provide guidance to WDNR compliance staff in the event of a spill and instruct compliance staff to immediately report observed oil sheens or slicks to Washington State Department of Ecology and the United States Coast Guard.

1.5 Harvest Compliance

WDNR will provide assurance that harvest occurs in accordance with all protective and avoidance measures in the Geoduck HCP by having compliance staff aboard vessels on harvest tracts each day that commercial geoduck harvest occurs. Compliance staff will maintain direct oversight of the fishery, and perform enforcement activities. A WDNR enforcement vessel will be on the tract or within visual distance of the tract daily (except for emergency and operational requirements). Enforcement staff will ensure that WDFW laws and regulations, WDNR contract conditions, and the conservation measures in the Geoduck HCP are followed. Results of this compliance monitoring will be reported to the Services at annual meetings.

1.6 Specific Measures for Covered Species

Bull Trout

Shoreward tract boundaries along the –18 foot MLLW depth contour protect shallow, nearshore habitats used by bull trout for foraging and rearing. This habitat includes eelgrass, macroalgae, and other vegetation. Buffers around eelgrass and other vegetation protect these potential cover and food sources for bull trout. Measures to address potential effects to forage fish species will reduce potential impacts to bull trout resulting from reductions in their prey base.

Coastal Cutthroat Trout

Shoreward tract boundaries along the –18 foot MLLW depth contour protects shallow nearshore habitats used by coastal cutthroat trout for foraging and rearing. This habitat includes eelgrass, macroalgae, and other vegetation. Buffers around eelgrass and other vegetation protect these potential cover and food sources for cutthroat trout.

Marbled Murrelet

Potential disturbance of marbled murrelets (murrelet) due to noise from harvest vessels is minimized by the established noise restrictions. Measures to address potential effects to forage fish species will reduce potential impacts to murrelets resulting from reductions in their prey base.

California Brown Pelican

Potential disturbance of California brown pelicans (brown pelican) due to noise from harvest vessels is minimized by the established noise restrictions. Measures to address potential effects to forage fish species will reduce potential impacts to brown pelican resulting from reductions in their prey.

Bald Eagle

WDNR will avoid nesting eagles and reduce the possibility of disturbing nesting and foraging eagles by adjusting harvesting times and tract boundary setbacks, if needed, in the vicinity of eagle nests. Setback distances from nests will vary on a site-specific basis, but harvest boats will always be at least 600 feet from shore. Individual tracts will be assessed to determine the need to adjust the tract boundary or timing of harvest in relation to eagle nests and nesting periods. WDNR will obtain information from WDFW staff to determine the need for setbacks for eagle nests, setback distances, and adjustments to harvest timing.

Potential disturbance of eagles due to noise from harvest vessels is minimized by the established noise restrictions and tract boundary setbacks from eagle nests.

Tufted Puffin

When performing Environmental Assessments for tracts in the vicinity of National Wildlife Refuges, other bird sanctuaries, or other areas that may be used for nesting by tufted puffins (e.g., Protection Island and Smith Island), WDNR will coordinate with appropriate FWS staff to verify setback distances and address other concerns. This will occur each time these tracts are harvested so that new information and science as to nesting locations can be considered in establishing setbacks. Harvest boats will always be at least 600 feet from shore. The assessment of tracts on a site-specific basis as to their location in relation to puffin nesting colonies will allow avoidance and minimization measures to be incorporated into harvest management of the tract. The occurrence of tufted puffins nesting colonies will be noted when Environmental Assessments are prepared for harvest tracts. Presently, only two existing harvest tracts are in the vicinity of one known nesting colony, but other colonies could be discovered in the future. Disturbance of nesting and foraging tufted puffins will be avoided by maintaining distances of at least 600 feet between harvest boats and shorelines and following setback requirements of any bird sanctuaries.

Potential disturbance of puffins due to noise from harvest vessels is minimized by the established noise restrictions. Measures to address potential effects to forage fish species will reduce potential impacts to tufted puffins resulting from reductions in their prey base.

Forage Fish

Forage fish constitute a major source of prey for several of the covered species including bull trout, coastal cutthroat trout, marbled murrelet, brown pelican, and tufted puffin.

Pacific Herring

The assessment of tracts on a site-specific basis as to their location in relation to Pacific herring spawning areas will allow avoidance and minimization measures to be incorporated into harvest management of the tract. The removal of individual geoducks using hand-operated water jets will minimize disturbance to the substrate and associated fauna, and keep turbidity to a minimum. This will reduce associated impacts to Pacific herring and Pacific herring spawning areas in the vicinity of the tracts.

Shoreward tract boundaries along the -18 foot MLLW depth contour will protect shallow nearshore habitats and spawning areas used by herring. This habitat includes eelgrass, macroalgae, and other substrate. Buffers around eelgrass and other herring spawning vegetation protect them from disturbance. Deeper water restrictions during spawning times (-35 feet) avoids disturbing Pacific herring spawning. Buffers of -25 feet MLLW protect potential Pacific herring spawning habitat during other times of the year.

Pacific Sand Lance

Shoreward tract boundaries along the –18 foot MLLW depth contour will protect intertidal habitats and spawning areas used by sand lance. This habitat includes eelgrass, macroalgae, other vegetation and beaches. Buffers around eelgrass and other vegetation protect these potential cover and food sources.

The removal of individual geoducks using hand-operated water jets will minimize disturbance to the substrate and associated fauna, and keep turbidity to a minimum. This will reduce associated impacts to Pacific sand lance and Pacific sand lance spawning areas in the vicinity of the tracts.

Surf Smelt

Shoreward tract boundaries along the –18 foot MLLW depth contour will protect intertidal habitats and spawning areas used by surf smelt. This habitat includes eelgrass, macroalgae, other vegetation and beaches. Buffers around eelgrass and other vegetation protect these potential cover and food sources.

The removal of individual geoducks using hand-operated water jets will minimize disturbance to the substrate and associated fauna, and keep turbidity to a minimum. This will reduce associated impacts to surf smelt and surf smelt spawning areas in the vicinity of the tracts.

2.0 ACTION AREA

The waters of Puget Sound, the Strait of Juan de Fuca and the San Juan Islands are divided into six Management Regions (see Figure 2.1). The six management regions combined constitutes the Action Area. The extent of surveyed geoduck resources potentially available for harvest across all six management regions is more precisely shown in Figure 2.2.

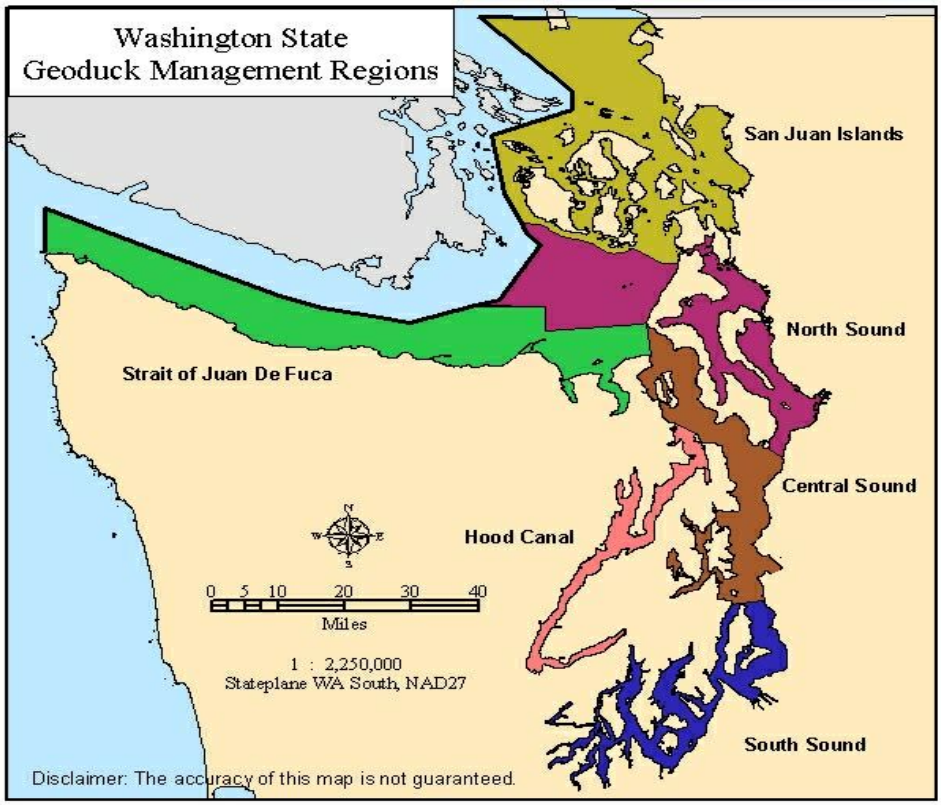

Figure 2.1 Map of the six Geoduck Management Regions in Washington.

Strait of Juan de Fuca

The Strait of Juan de Fuca management region encompasses waters east of a line projected true north from Cape Flattery to the international boundary line; and those waters west and south of a line projected from Point Wilson to Partridge Point, Whidbey Island, then westerly to the vessel traffic service buoy "S", north of Dungeness Spit, then north to the vessel traffic service buoy "R", then due west to the international boundary line, then westerly along the international boundary line to a point where the international boundary line intersects the line projected from Observatory Point. This management region covers about 449,700 acres and has 5,572 acres of commercially available geoduck tracts.

North Sound

The North Sound management region encompasses waters east of Whidbey Island north of a line projected from Possession Point, Whidbey Island to Picnic Point on the mainland; south of the railroad bridges at Swinomish Channel; and east of the Deception Pass bridge. Those waters west of Whidbey Island and north of a line projected from Partridge Point, Whidbey Island westerly to vessel traffic service buoy “S”, north of Dungeness Spit, then north to the vessel service buoy “R”, then due west to the international boundary line; and south of a line projected due east from the international boundary line to a point one nautical mile west of Pile Point, San Juan Island, then southeasterly along a line one nautical mile from the southern shores of San Juan Island and Lopez Island to Davidson Rock near Point Colville, then easterly to a point one

nautical mile south of the buoy at Lawson Reef and then due east to Whidbey Island. This management region covers about 356,900 acres and has 1,515 acres of commercially available geoduck tracts.

Central Sound

The Central Sound management region encompasses waters north of a line projected from the ferry dock at Point Southworth to Brace Point, not including the waters of Hood Canal; northeasterly of a line projected from Olele Point to Foulweather Bluff; easterly of a line projected from Point Wilson to Partridge Point, Whidbey Island; and southerly of a line projected easterly from Possession Point, Whidbey Island to Picnic Point on the mainland. This management region covers about 231,700 acres and has 8,968 acres of commercially available geoduck tracts.

Hood Canal

The Hood Canal management region encompasses waters south of a line projected from Olele Point to Foulweather bluff including the area described as Dabob Bay. This management region covers about 100,400 acres and has 5,165 acres of commercially available geoduck tracts.

South Sound

The South Sound management region encompasses waters south of a line projected from the ferry dock at Point Southworth to Brace Point, except waters of Hood Canal. This management region covers about 172,100 acres and has 8,688 acres of commercially available geoduck tracts.

San Juan Islands

The San Juan Islands management region encompasses waters north of a line projected due east from the international boundary line to a point one nautical mile west of Pile Point, San Juan Island, then southeasterly along a line one nautical mile from the southern shores of San Juan Island and Lopez Island to Davidson Rock near Point Colville, then easterly to a point one nautical mile south of the buoy at Lawson Reef and then due east to Whidbey Island; and north of the railroad bridge at Swinomish Channel; and west of the Deception Pass bridge; and south and east of the international boundary line. This management region covers about 518,100 acres and has geoduck beds identified, but most have not been surveyed. No commercial harvest is currently allowed in the San Juan Islands management region, but it is included in the Geoduck HCP because harvest will occur there in the future.

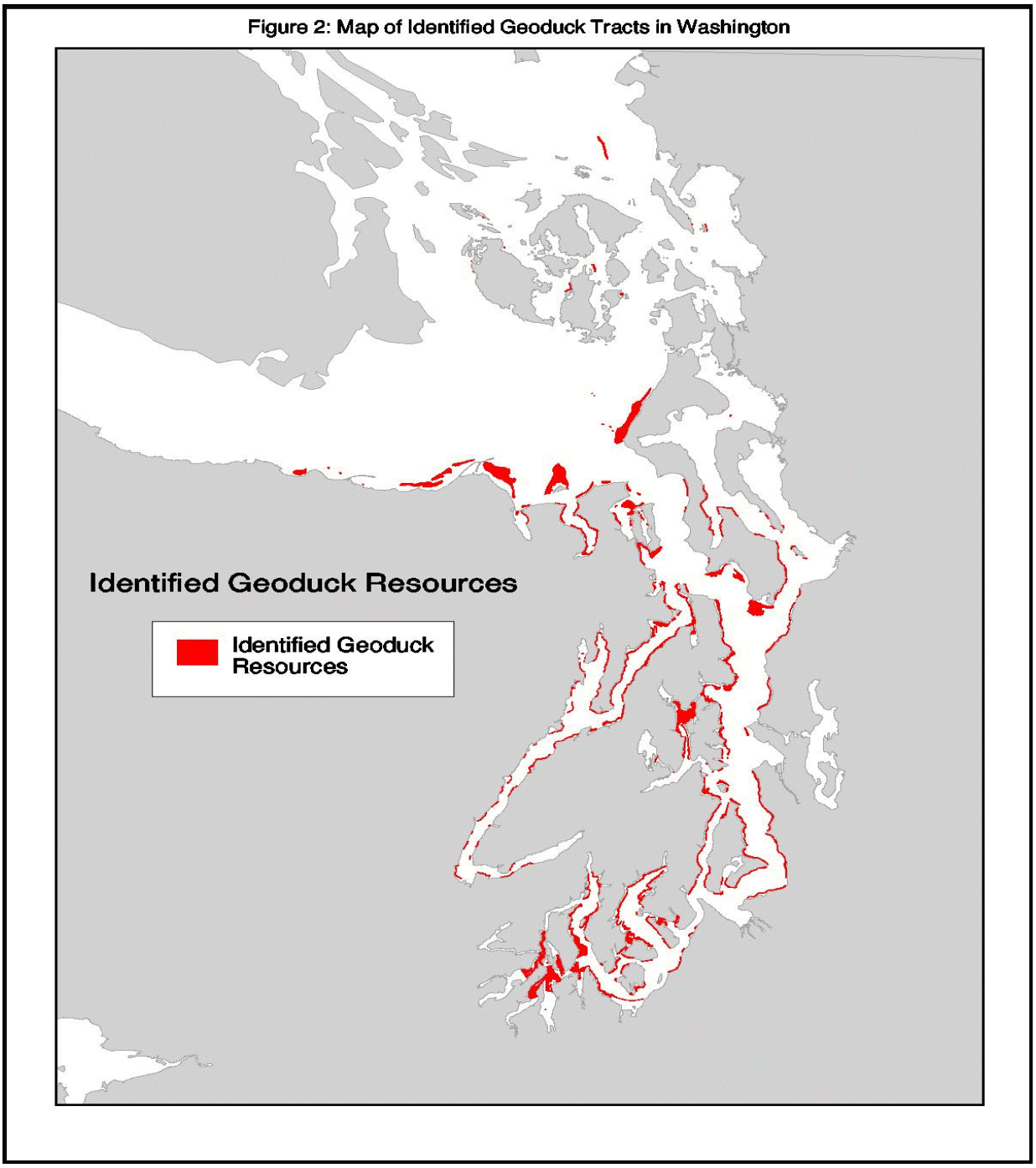

Figure 2.2 Map of Identified Geoduck Tracts in Washington.

Distribution of Geoducks Tracts Available for Commercial Harvest

A geoduck tract is any subtidal area with well-defined boundaries which has been surveyed and found to contain geoducks of commercial quantity and quality. The tract boundaries are artificial and not tied solely to biological criteria. Geoduck tracts have been identified by WDFW, WDNR, and the Tribes within each of the six management regions across the extent of the inventoried resource shown in Figure 2.2. The total acreage of surveyed tracts (i.e., the entire extent of the surveyed resource) fluctuates, but is about 30,000 acres. Future surveys could identify additional commercial tracts. The total acreage available for commercial harvest fluctuates because newly discovered beds are added, or the status of an existing tract is changed and those acres subtracted from the total acreage available for commercial harvest. The commercial status of a tract can change if a tract is rendered unharvestable by pollution, a tract gets fished down to where it is put into recovery status, or geoduck densities are too low for a viable commercial fishery.

The State of Washington Geoduck Atlas is a tract-specific compilation and update of information on geoduck tracts based on annual dive surveys performed by WDFW. For each tract, the Geoduck Atlas states the estimated tract size in acres (from GIS data), estimated number of geoducks and biomass (in pounds), average geoduck density (number of geoducks per square foot) and average weight (in pounds) of geoducks on the tract.

The Geoduck Atlas also documents other features or conditions of the tract noted during the survey such as the presence of eelgrass, known water quality issues, the presence of herring spawning areas, and other information important in assessing the suitability of the tract for commercial harvest. The Geoduck Atlas is updated each year by WDFW (http://www.wdfw.wa.gov/fish/shelfish/geoduck/index.htm). There are nearly 400 individual geoduck tracts identified in the Geoduck Atlas. Sometimes large areas are divided into several tracts. Data in the Geoduck Atlas show individual tracts ranging in size from 4 acres to 1,197 acres (0.02 to 4.8 km^2), but most (more than 60 percent) are less than 200 acres (0.8 km^2) in size and only 18 tracts are 300 acres (1.2 km^2) or larger.

Surveys conducted for assessing tracts for inclusion in the Geoduck Atlas are only performed within a narrow bathymetric band. Shoreward, the boundary is at the -18 ft line (corrected to the mean lower low water [MLLW] level). Seaward, surveys stop at the -70 ft depth, adjusted to MLLW, because this is the limit at which divers can most efficiently survey the resource using compressed air SCUBA and the Navy dive table. Geoducks occur across a broader range, both deeper and shallower, than the current commercial tract depth limits.

Commercial harvest is limited to the same narrow bathymetric band. Harvest boats must stay at least 200 yards (600 feet) seaward from the line of ordinary high tide, but divers can venture further shoreward, within the constraints of their dive equipment, but cannot harvest shoreward of the -18 foot boundary. The shoreward boundary acts to protect geoducks closer to shore as well as eelgrass beds, forage fish spawning areas, and other nearshore habitats and their inhabitants (e.g., juvenile fish). Seaward, no harvest occurs deeper than -70 feet MLLW. As with survey boundary, the seaward, deep-water boundary is the limit at which harvest divers can efficiently operate for workable periods.

The -18 foot shoreward boundary is not absolute. The shoreward boundary is adjusted deeper to avoid eelgrass (for example), to eliminate rocky areas from the tract, to avoid conflicts with areas such as aquatic lands adjoining State parks, or for other reasons. The -70 foot depth boundary is stated in WAC 220-52-019(11). This rule was recently changed (effective September 2006) to allow the -70 foot boundary to be corrected to MLLW. Previously, the -70 foot depth contour that establishes this boundary was uncorrected, meaning it was dependent on the tidal cycle; it would fluctuate with the tide up to a distance of 4.5 feet. The changed rule clearly identifies a fixed boundary for harvest tracts that is consistent with the boundary of surveyed areas. Some existing harvest agreements are still operating under the previous rule language because it is specified in shoreline permits issued to WDNR for geoduck harvest. The shoreline permits are good for five years. Once they expire and new ones are obtained, harvest agreements will be issued with language reflecting the updated rule. Not all counties require WDNR to obtain shoreline permits. Only those tracts where shoreline permits are required, and have been issued with restricted shoreline permit language will be under the old rule.

2.1 Species Covered by the HCP

Species proposed for coverage in the Geoduck HCP include eight species of fish, 4 bird species, one marine mammal and two invertebrates. Species addressed in this biological opinion are listed in Table 2.1. NMFS has jurisdiction over the other 9 species.

Table 2.1 Species covered in the Incidental Take Permit for the State of Washington's Commercial Geoduck Fishery Habitat Conservation Plan

Common Name	***Scientific Name***
Threatened and Endangered Species	
Bull trout	*Salvelinus confluentus*
Marbled murrelet	*Brachyramphus marmoratus*
California brown pelican	*Pelecanus occidentalis*
Unlisted Species	
Tufted puffin	*Fratercula cirrhata*
Coastal cutthroat trout	*Oncorhynchus clarki clarki*
Bald eagle	*Haliaeetus leucocephalus*

2.2 Activities Covered by the HCP

WDNR is responsible for the sales and harvest management of the State's portion of the wildstock geoduck fishery. Harvest quotas from specific management regions are auctioned for harvest about four times per year. Commercial harvest activities that are managed by WDNR, including harvest for research, survey, and health sampling, are covered in the Geoduck HCP.

Timing

Commercial geoduck harvest administered by WDNR occurs year-round. Harvest is allowed Monday through Friday, from 8:00 a.m. to 4:30 p.m. and does not occur on State holidays or weekends. Each harvester operates during the period specified in their harvesting agreement (generally 2-4 months). It may take several years over the course of several harvest cycles to complete harvest on one commercial geoduck tract. About 70 percent of the geoduck biomass is removed during harvest, after which, the tract is allowed to recover to the pre-harvest biomass. Activities that occur outside this specified window are not covered by the Geoduck HCP.

Access to Commercial Tracts – Vessels

Commercial geoduck tracts are accessed via boat. The boats range from 25 to 70 feet long and are anchored during harvest activities. Harvest boats sit with idling engines for most of the day. A boat might re-anchor two to three times a day as it repositions on the tract being harvested. Boats cannot enter the tract boundary prior to the harvest start time each day and they are not legally allowed to stay on the tracts after the daily harvest.

Onboard compressors provide air for the divers via hoses up to 400 feet long. Onboard pumps deliver pressurized water for the water jet nozzles used to remove the geoducks. Dive boats can, and usually do, maintain two divers in the water at a time. A third person (tender) stays on board to monitor equipment and to bring harvested geoducks onboard. The tender and divers stay in constant verbal contact using a surface-to-diver communication system.

Through contract management, WDNR limits the number of boats actively harvesting at one time and place. Typically eight to ten boats are in operation at one time. Harvesting agreements require vessels to operate at surface noise levels less than 50 decibels measured at 200 yards (600 feet) from the source; a level less than the state standard.

WDNR's Compliance Activities

WDNR maintains a commercial dive team whose primary responsibility is the daily on-water management, enforcement, and harvesting agreement compliance of the tract harvest. Dive team members are skilled in scuba and surface-supplied diving techniques, investigative procedures and boat handling. WDNR's compliance staff has a boat on the tract at all times during harvest. The compliance boat contains spill containment materials and can respond to fuel spills and other emergencies. In addition to ensuring that all harvest restrictions, State fishery laws and regulations, and harvesting agreement conditions are followed; WDNR maintains oversight of the condition and operation of harvest vessels.

Harvest Methods and Equipment

Geoducks are harvested individually by divers using hand operated water jets. The water jet is a pipe about 18 to 24 inches long with a nozzle on the end which releases water at a pressure of about 40 to 60 psi, about the same pressure as that from a standard garden hose. The size of the nozzle on the water jets is limited to a maximum inside tip diameter of 5/8 inch (by WDFW via

WAC 220-52-019(2a)). The water jet is controlled by the diver. It is inserted in the substrate next to the exposed geoduck siphon or in the hole left when the siphon is retracted. By discharging pressurized water around the clam the sediment is loosened and the clam is removed by hand. Each diver carries a mesh bag to collect the harvested geoducks. The bag holds about 180 pounds, or 50-80 clams. Divers periodically surface to unload their bags. A diver can harvest about 800 geoducks per day on a high-density commercial tract with good digging conditions. Intakes for supplying water to the onboard pumps that then deliver water to the water jet, are positioned about 10 to 20 feet below the water surface. Intake openings are 4-6 inches in diameter and are screened to prevent debris from stalling the pump.

After the geoducks are brought onboard, they are weighed and fish receiving tickets (previously issued by WDFW) are filled out in the presence of, and authenticated by, WDNR compliance staff. After being unloaded at a pre-approved marina or boat ramp, the geoducks are transported to a wholesaler or directly to market.

Harvest

Tracts selected for harvest are generally concentrated in a single geographic area to make enforcement easier, allow efficiency in survey efforts, and to more efficiently identify and address other concerns. The fishery operates year-round, but harvest activities on a particular tract do not occur year-round because harvest is intentionally rotated around the different regions. In addition, water quality deterioration or paralytic shellfish poisoning (PSP) occurrence can cause termination or suspension of harvest on a specific tract. Harvest stops when the tract has been "fished down" to the thresholds identified in annual management plans; generally about 30 percent of the estimated pre-harvest tract density. Tribal sharing agreements can limit the biomass taken from a given tract. Harvest on a particular tract can be suspended or terminated for other reasons as well.

3.0 STATUS OF THE SPECIES: Bull Trout – Rangewide

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 (Bond 1992; Brewin and Brewin 1997; Cavender 1978; Leary and Allendorf 1997).

Throughout its range, the bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 58910). Although all salmonids are likely to be affected by climate change, bull trout are

especially vulnerable given that spawning and rearing are constrained by their location (upper reaches of watersheds) and their requirement for cold water temperatures (Battin et al. 2007; Rieman et al. 2007). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (63 FR 31647; 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the 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 (DIO 2002; 2004a,b,c). 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 FWS's draft recovery plans for the bull trout (FWS 2002; 2004b,c).

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 (FWS 2002; 2004b,c) 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 (FWS 2002; 2004b,c). 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 (FWS 2002; 2004b,c).

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 (FWS 2004c). The draft bull trout recovery plan (FWS 2004c) 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 (FWS 2004c).

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 (FWS 2002). Bull trout populations in this interim recovery unit face a high risk of extirpation (FWS 2002). The draft Klamath River bull trout recovery plan (FWS 2002) 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 (FWS 2002).

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 *in litt.* 1995). The draft Columbia River bull trout recovery plan (FWS 2002) 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 FWS 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 (FWS 2005b).

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 (FWS 2004b). 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 (FWS 2004b) 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 (FWS 2002). Currently, bull trout are widely distributed in the St. Mary-Belly 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 (FWS 2002). 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 (FWS 2002). The draft St. Mary-Belly bull trout recovery plan (FWS 2002) 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 et al. 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 (Fraley and Shepard 1989; Leathe and Graham 1982; 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 (Goetz 1989; Pratt 1985). 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; Howell and Buchanan 1992; Pratt 1992; Rich 1996; Rieman and McIntyre 1993, 1995; Sedell and Everest 1991; 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 (Gilpin *in litt.* 1997; Rieman et al. 1997; Rieman and McIntyre 1993). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to non-natal 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 quality, as these fish are primarily found in colder streams (below 15°C or 59°F), and spawning habitats are generally characterized by temperatures that drop below 9°C (48°F) in the fall (Fraley and Shepard 1989; 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 (Baxter et al. 1997; Pratt 1992; Rieman and McIntyre 1993; 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 (Buchanan and Gregory 1997; Fraley and Shepard 1989; Rieman et al. 1997; Rieman and McIntyre 1993, 1995). 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; Pratt 1992; Rich 1996; Sedell and Everest 1991; Sexauer and James 1997; Thomas 1992; 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).

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

A literature review conducted by the Washington Department of Ecology (2002) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). In a laboratory study conducted in Canada, researchers found that low oxygen levels retarded embryonic development in bull trout (Giles and Van der Zweep1996 *cited in*: Stewart et al. 2007). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes or nearshore marine habitat where foraging opportunities may be enhanced (Brenkman and Corbett 2005; Frissell 1993; Goetz et al. 2004b). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999; MBTSG 1998; Rieman and McIntyre 1993). 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).

Marine Habitat Use

Anadromous adult and subadult bull trout utilize nearshore marine waters, which includes the estuaries and shoreline areas. This nearshore environment provides habitat critical to both bull trout and salmon. This habitat provides food production and foraging areas, refuge (from predation, seasonal high flows, winter storms, etc.), and migratory corridors.

In two recent telemetry studies documenting the extent of anadromy in bull trout within portions of the Coastal-Puget Sound IRU, approximately 55 percent of the fish tagged in freshwater emigrated to saltwater (Brenkman and Corbett 2005; Goetz et al. *in litt.* 2007). Some level of mixing or interaction within marine waters occurs among anadromous individuals from various core areas. Based on recent studies it is likely that bull trout from several core areas may be present within a nearshore area simultaneously (Brenkman and Corbett 2005; Goetz et al. 2004a; Brenkman et al. 2007; Goetz et al. *in litt.* 2007). Results from these studies also demonstrate that anadromous bull trout inhabit a diverse range of estuarine, freshwater, and marine habitats.

Marine waters provide important habitat for anadromous bull trout for extended periods of time. Data for bull trout from Puget Sound indicate that the majority of anadromous bull trout tend to migrate into marine waters in the spring and return to rivers in the summer and fall periods. Although much less frequent, tagged fish have been detected in Puget Sound nearshore marine waters during December and January, which indicates that some fish remain in marine waters during the winter (USGS *in litt.* 2008; Goetz et al. 2004a). Warmer water temperatures in the summer may be one environmental cue that stimulates bull trout to return to freshwater. Other factors that may influence marine residency for bull trout include prey availability, predation risks, or spawn timing.

In general, anadromous bull trout use shallow nearshore waters, including subtidal and intertidal waters. In the study by Goetz and others (2004) the greatest bull trout densities were at depths greater than 2.0-2.5 m. Upon entering marine waters bull trout can make extensive, rapid migrations, usually in nearshore marine areas. During the majority of their marine residency, anadromous bull trout have been found to occupy territories ranging in size from ~10 meters to >3 km and located within 100-400 meters of the shoreline (USGS *in litt.* 2008). Aquatic vegetation and substrate common to all or most bull trout areas includes eelgrass, green algae, sand, mud, and mixed fine substrates. These habitat features are also correlated with forage fish occurrence.

Nearshore marine habitats in Puget Sound have been significantly altered by human development (PSWQAT 2000). Construction of bulkheads and other structures have modified the nearshore areas and resulted in habitat loss that has directly affected forage fish populations used by bull trout. Other impacts to the marine environment include alterations to water quality resulting from fish pathogens, nutrients and toxic contaminants, urbanization, and stormwater runoff from basins that feed Puget Sound. Global changes in sea level and climate may also have widespread ramifications on these habitats and on the Puget Sound ecosystem as a whole.

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

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 occurs 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. 2004b).

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 HCPs completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP, 2) Green Diamond 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-Belly 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 Bull Trout Core Areas: Puyallup Core Area

The Puyallup core area comprises the Puyallup, Mowich, and Carbon Rivers; the White River system, which includes the Clearwater, Greenwater, and the West Fork White Rivers; and Huckleberry Creek. Glacial sources in several watersheds drain the north and west sides of Mount Rainier and significantly influence water, substrate, and channel conditions in the mainstem reaches. The location of many of the basin's headwater reaches within Mount Rainier National Park and designated wilderness areas (Clearwater Wilderness, Norse Peak Wilderness) provides relatively pristine habitat conditions in these portions of the watershed.

Anadromous, fluvial, and potentially resident bull trout occur within local populations in the Puyallup River system. Bull trout occur throughout most of the system although spawning occurs primarily in the headwater reaches. Anadromous and fluvial bull trout use the mainstem reaches of the Puyallup, Carbon, and White Rivers to forage and overwinter, while the anadromous form also uses Commencement Bay and likely other nearshore areas within Puget Sound. Habitat conditions within the lower mainstem Puyallup and White Rivers have been highly degraded, retaining minimal instream habitat complexity. In addition, habitat conditions within Commencement Bay and adjoining nearshore areas have been severely degraded as well, with very little intact intertidal habitat remaining.

The Puyallup core area has the southernmost, anadromous bull trout population in the Puget Sound Management Unit (FWS 2004b). Consequently, maintaining the bull trout population in this core area is critical to maintaining the overall distribution of migratory bull trout in the management unit.

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 (FWS 2004b).

Number and Distribution of Local Populations

Five local populations occur in the Puyallup core area: 1) Upper Puyallup and Mowich Rivers, 2) Carbon River, 3) Upper White River, 4) West Fork White River, and 5) Greenwater River. The Clearwater River is identified as a potential local population, as bull trout are known to use this river and it appears to provide suitable spawning habitat, but the occurrence of reproduction there is unknown (FWS 2004b).

Information about the distribution and abundance of bull trout in this core area is limited because observations have generally been incidental to other fish species survey work. Spawning occurs in the upper reaches of this basin where higher elevations produce the cold water temperatures required by bull trout egg and juvenile survival. Based on current survey data, bull trout spawning in this core area occurs earlier in the year (i.e., September) than typically observed in other Puget Sound core areas (Marks et al. 2002). The known spawning areas in local populations are few in number and not widespread. The majority of spawning sites are located in streams within Mount Rainier National Park, with two exceptions, Silver Creek and Silver Springs (R. Ladley, Puyallup Tribe, Tacoma, WA, *in litt*. 2006; Marks et al. 2002).

Rearing likely occurs throughout the Upper Puyallup, Mowich, Carbon, Upper White, West Fork White, and Greenwater Rivers. However, sampling indicates most rearing is confined to the upper reaches of the basin. The mainstem reaches of the White, Carbon, and Puyallup Rivers probably provide the primary freshwater foraging, migration, and overwintering habitat for migratory bull trout within this core area.

With fewer than 10 local populations, the Puyallup core area is considered to be at intermediate risk of extirpation and adverse effects from random naturally occurring events.

Adult Abundance

Rigorous abundance estimates are generally not available for local populations in the Puyallup core area. Currently, fewer than 100 adults probably occur in each of the local populations in the White River system, based on adult counts at Mud Mountain Dam's Buckley Diversion fish trap. Although these counts may not adequately account for fluvial migrants that do not migrate downstream of the facility, these counts do indicate few anadromous bull trout and few mainstem fluvial bull trout return to local populations in the White River system. Therefore, the bull trout population in the Puyallup core area is considered at increased risk of extirpation until sufficient information is collected to properly assess adult abundance in each local population.

Productivity

Due to the current lack of long-term, comprehensive trend data, the bull trout population in the Puyallup core area is considered at increased risk of extirpation until sufficient information is collected to properly assess productivity.

Connectivity

Migratory bull trout are likely present in most local populations in the Puyallup core area. However, the number of adult bull trout expressing migratory behavior within each local population appears to be very low compared to other core areas. Although connectivity between the Upper Puyallup and Mowich Rivers local population and other Puyallup core area local populations was reestablished with the creation of an upstream fish ladder at Electron Dam in 2000, this occurred after approximately 100 years of isolation. Very low numbers of migratory bull trout continue to be passed upstream at the Mud Mountain Dam's Buckley Diversion fish trap. The overall low abundance of migratory life history forms limits the possibility for genetic exchange and local population refounding, as well as limits more diverse foraging opportunities to increase size of spawners and therefore, overall fecundity within the population. Consequently, the bull trout population in the Puyallup core area is at intermediate risk of extirpation from habitat isolation and fragmentation.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, the FWS has issued Opinions that exempted incidental take in the Puyallup core area. These incidental take exemptions were in the form of harm and harassment, primarily from hydrologic impacts associated with increased impervious surface, temporary sediment increases during in-water work, habitat loss or alteration, and handling of fish. None of these projects were determined to result in jeopardy to bull trout. The combined effects of actions evaluated under these Opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the core area.

Of particular note, in 2003 the FWS issued an Opinion (FWS Ref. No. 1-3-01-F-0476) on the State Route 167 North Sumner Interchange Project. This project was located in Pierce County in the White River portion of the Puyallup watershed and was proposed by Washington State Department of Transportation. The project's direct and indirect impacts and cumulative impacts within the action area included urbanization of approximately 600 acres of land. We anticipated that conversion of this land to impervious surface would result in the permanent loss and/or degradation of aquatic habitat for bull trout and their prey species through reduced base flows, increased peak flows, increased temperatures, loss of thermal refugia, degradation of water quality, and the degradation of the aquatic invertebrate community and those species dependent upon it (bull trout prey species). These impacts will result in thermal stress and disrupt normal behavioral patterns. Incidental take of fluvial, adfluvial, and anadromous bull trout in the form of harassment due to thermal stress and the disruption of migrating and foraging behaviors was exempted for this project. These adverse effects were expected to continue in perpetuity.

Section 10(a)(1)(B) permits have also been issued for HCPs that address bull trout in this core area. Although these HCPs may result in both short and/or long-term negative effects to bull trout and their habitat, the anticipated long-term beneficial effects are expected to maintain or improve the overall baseline status of the species. Additionally, capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have directly affected some individual bull trout in this core area.

The number of non-Federal actions occurring within the Puyallup core area since the bull trout were listed is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance affect riparian and instream habitat which typically results in negative affects to bull trout and their habitat.

Threats

Threats to bull trout in the Puyallup core area include the following:

- Extensive past and ongoing timber harvest and harvest-related activities, such as road maintenance and construction, continue to affect bull trout spawning and rearing areas in the upper watershed.

- Agricultural practices, such as bank armoring, riparian clearing, and non-point discharges of chemical applications continue to affect foraging, migration, and overwintering (FMO) habitats for bull trout in the lower watershed.

- Dams and diversions have significantly affected migratory bull trout in the core area. Until upstream passage was recently restored, the Electron Diversion Dam isolated bull trout in the Upper Puyallup and Mowich Rivers local population for nearly 100 years and has drastically reduced the abundance of migratory bull trout in the Puyallup River. Buckley Diversion and Mud Mountain Dam have significantly affected the White River system in the past by impeding or precluding adult and juvenile migration and degrading foraging, migration, and overwintering habitats in the mainstem. Despite improvements to these facilities, passage related impacts continue today but to a lesser degree.

- Urbanization, road construction, residential development, and marine port development associated with the city of Tacoma, have significantly reduced habitat complexity and quality in the lower mainstem rivers and associated tributaries, and have largely eliminated intact nearshore foraging habitats for anadromous bull trout in Commencement Bay.

- The presence of brook trout in many parts of the Puyallup core area and their potential to increase in distribution, including into Mount Rainer National Park waters, are considered significant threats to bull trout. Because of their early maturation and competitive advantage over bull trout in degraded habitats, brook trout in the upper Puyallup and Mowich rivers local population is of highest concern because of past isolation of bull trout and the level of habitat degradation in this area.

- Until the early 1990s, bull trout fisheries probably significantly reduced the overall bull trout population within this and other core areas in Puget Sound. Current legal and illegal fisheries in the Puyallup core area may continue to significantly limit recovery of the population because of the low numbers of migratory adults.

- Water quality has been degraded due to municipal and industrial effluent discharges resulting from development, particularly in the lower mainstem Puyallup River and Commencement Bay.

- Water quality has also been degraded by stormwater discharge associated with runoff from impervious surface. Impervious surface in the Puyallup watershed increased by 12 percent between 1990 and 2001 (Puget Sound Action Team 2007).

- Major flood events in November 2006 significantly impacted instream habitats within the Puyallup River system. These events are assumed to have drastically impacted bull trout brood success for the year, due to significant scour and channel changes that occurred after peak spawning. Significant impacts to rearing juvenile bull trout were also likely, further impacting the future recruitment of adult bull trout.

- In November 2006, an 18,000 gallon diesel spill in the head waters of Spring Creek (C. Hebert, FWS, Portland, Oregon, *in litt.* 2006), a bull trout spawning area of the Upper White River local population, likely impacted the available instream spawning habitat. The duration of ongoing contamination of instream habitats by residual diesel is unknown.

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 Millardy, 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 (FWS 2004b). There are no known populations in the North Fork Stillaguamish River above the barrier to migration at river mile 37.5 (C. Kraemer, WDFW, *in litt*. 1999). 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 1998a).

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 have 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 river 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 Creek 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 (M. Downen, *in litt*. 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. 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.

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 (FWS 2004b).

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, bull trout in this core area are considered to be at increased risk of extirpation and adverse effects from random naturally occurring events.

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 river miles 21 and 25 during fall 2001; fewer than 100 adults were counted in the remaining sample years between 1996 and 2003 (G. Pess, NMFS, *in litt*. 2003). Other limited snorkel surveys had similar results (M. Downen, pers. comm. 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 (M. Downen, *in litt*. 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 sub-adults 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 statewide Federal restoration programs that include riparian restoration, restoration of fish passage at barriers, and habitat-improvement projects. In addition, federally funded transportation projects involving repair and protection of roads and bridges have been completed. Finally, 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, affect riparian and instream habitat and probably negatively affect bull trout.

Threats

Threats to bull trout in the Stillaguamish core area include the following:

- 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 logging and logging-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 have adversely affected bull trout in Deer Creek and in the South Fork Stillaguamish River (WDFW 1997; FWS 2004b). Deer and Higgins Creeks currently violate State water-quality standards for temperature.

- Agricultural and residential development has 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, contribute 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 (FWS 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).

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 (FWS 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. Most of the spawners in the core area occur in the North Fork Skykomish local population. Redd counts within the North Fork Skykomish local population peaked at over 530 in 2002 (FWS 2004b), but have recently declined to just over 240 in 2005 and 2006 (WDFW 2007a). 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, Washington Department of Fish and Wildlife, pers. comm. 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, 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 HCPs addressing forest management practices. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have 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, affect riparian and instream habitat and probably negatively affect bull trout.

Threats

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

- 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 the 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.

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 River including the lake systems (Baker Lake and Lake Shannon) upstream of upper and lower 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 several locations in the core area, often occur with migratory life history forms. Adfluvial bull trout occur in Baker, Shannon, 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, *in litt.* January 2003; WDFW et al. 1997).

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.

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 (FWS 2004b).

Number and Distribution of Local Populations

Nineteen local populations were identified in the draft recovery plan (FWS 2004b): 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 in the draft recovery plan (FWS 2004b), 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 (R2 Resource Consultants and Puget Sound Energy 2005; J. Shannon, *in litt*. October 2004). 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 (C. Kraemer, *in litt*. July 2001). Consequently, the bull trout population in this core area is not considered at risk from genetic drift.

The majority of local populations in the core area include 100 adults or more; therefore, they are at a diminished risk of extirpation. However, some local populations probably have fewer than 100 adults and may be at risk from inbreeding depression. There is some risk of extirpation of the following local populations due to their lower numbers of adults; however, other factors, such as stable or increasing population trends may reduce this risk. 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 (C. Kraemer, *in litt*. January 2003). Fewer than 100 adults probably occur in Tenas Creek, but this local population is presumed to be increasing. The Straight Creek local population includes fewer than 100 migratory adults and an unknown number of resident fish (C. Kraemer, *in litt*. July 2001), 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 (C. Kraemer, *in litt*. July 2001); however, resident and migratory components are considered stable. Based on recent observations, the Sulphur Creek local population in the Lake Shannon system also has fewer than 100 adults (R2 Resource Consultants and Puget Sound Energy 2006). Prior to 2004, Goodell Creek supported more than 100 adult spawners. In October 2003, a large landslide in Goodell Creek blocked access to the majority of spawning habitat for migratory bull trout in the Goodell Creek local population. Adult counts of migratory bull trout in 2004 and 2005 have been fewer than 100 individuals (M. Downen, *in litt*. 2006) in this local population. In the Baker Lake local population, annual peak counts of 85 adults have been recorded between 2001 and 2005 (R2 Resource Consultants and Puget Sound Energy 2006). Since the most upstream accessible habitat was not surveyed in these efforts and bull trout typically spawn as far upstream as they can within a stream system, this would suggest that on average there may be at least 100 adults in this local population. Total adult abundances in Newhalem and Stettatle Creek local populations are unknown.

Productivity

Long-term redd counts in the index areas of the Lower Skagit core area generally indicate stable to increasing population trends (FWS 2004b). Therefore, this core area is not considered at risk of extirpation at this time. Recent declines in redd counts may indicate a potential change to this long-term trend (M. Downen, *in litt*. 2006). Redd counts conducted by WDFW between 2002 and 2005 show a significant downward trend in Bacon, Goodell, and Illabot Creeks, and the Sauk River. However, Downey Creek had a significant increase in the reported redd counts between these years. The reason for these changes is unknown.

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 and Sulphur Creek local populations in the Baker River system and Stetattle Creek local population in the Gorge Lake system with other local populations in the core area is a concern with respect to long-term persistence, life history expression, and refounding. In addition, there is currently only partial connectivity within the Baker Lake system, with no upstream passage for adults within Lake Shannon at upper Baker Dam.

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 HCPs addressing forest management practices. Capture and handling, and indirect mortality, during implementation of section 6 and section 10(a)(1)(A) permits have negatively 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 and parts of their forage base.

Threats

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

- Gorge and Baker Dams restrict connectivity of the Stetattle Creek, Baker Lake, and Sulphur Creek (Lake Shannon) local populations with the majority of other local populations in the core area due to impaired fish passage.

- 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.

- Estuarine nearshore foraging habitats have been, and continue to be, negatively affected by agricultural practices and development activities.

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.

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 (FWS 2004b).

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 is considered at intermediate risk of local extirpation and adverse affects 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 extirpation 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, 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 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 the following:

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

- Bellingham Diversion 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 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.

Dungeness River Core Area

The Dungeness River core area includes the Dungeness and Grey Wolf Rivers, associated tributaries, and estuary. The Dungeness River core area is one of two core areas in the Olympic Peninsula Management Unit that are connected to the Strait of Juan de Fuca.

Bull trout occur throughout the Dungeness and Gray Wolf Rivers downstream of impassable barriers, which are present on both rivers. They also occur in the Dungeness River estuary and Gold Creek, a Dungeness River tributary. Char were sampled in the Dungeness River below the falls. One Dolly Varden was identified in the samples; the rest were bull trout (Spruell 2006). In an earlier genetic analysis, 50 char sampled upstream of the barrier falls at river mile 24 were all Dolly Varden (S. Young, WDFW *in litt*. 2001). It is likely that the Dolly Varden sampled below the falls was a fish that passed over the falls and was not able to return to its home range above the falls.

Fluvial and anadromous life history forms of bull trout occur in the Dungeness River core area. Mainstem rivers within the core area provide spawning, rearing, FMO habitats. The estuary also provides important foraging habitat. During a study in 2006 and 2007 by the Jamestown S'Klallam Tribe that targeted capture of salmon smolts, a number of bull trout were incidentally captured in fyke nets located in estuary feeder channels and during beach seining. These fish ranged in size from 117 to 380 millimeters and were often captured in the midst of juvenile pink and chum salmon and post larval surf smelt.

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 (FWS 2004b).

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

Two local populations have been identified: 1) middle Dungeness River up to river mile 24 and tributaries, including Silver, Gold, and Canyon Creeks, and 2) Gray Wolf River to confluence with Cameron, Grand, and Cedar Creeks. With only two local populations, bull trout in this core area are considered to be at increased risk of extirpation and adverse effects from random naturally occurring events.

<u>Adult Abundance</u>

From late August through November 2004, comprehensive redd surveys were conducted for the first time in the Gray Wolf and middle Dungeness Rivers. These surveys combined walking surveys with radio telemetry tracking. Eight redds were observed in the middle Dungeness, above the confluence with the Gray Wolf River and below the impassable barrier, and 32 redds were observed in the Gray Wolf River local population area. This probably represents approximately 90 percent of the redds in the two local populations (Ogg et al. 2008). In 2005, a

late spawning run of bull trout in the area around the confluence of the Gray Wolf and Dungeness Rivers was observed. Further study and analysis is needed to determine whether this group of spawners comprises a third local population. Other than the information from the surveys described above, little is known about adult abundance in the Dungeness River core area. This is mainly due to little survey effort (until recently) and the difficult access to the upper watershed. However, the Dungeness River core area probably supports at least 500 but fewer than 1,000 adults. With fewer than 1,000 adults, this population is considered to be at increased risk of genetic drift.

Productivity

Bull trout in the Dungeness core area are considered at risk of extirpation until sufficient information is collected to properly assess the productivity of this core area.

Connectivity

A number of barriers to fish movement and migration in the Dungeness River core area are due to improperly sized or installed culverts throughout the core area. Connectivity between the Dungeness River and its floodplain has been eliminated by diking to prevent flooding. Migration during late summer and early fall can be blocked by reduced flows from water diversions for irrigation in the lower Dungeness watershed. Migration at certain times of the year may be blocked by the WDFW fish hatchery collection rack on the lower Dungeness River. In addition, the hatchery water intake is a complete barrier to upstream fish passage in Canyon Creek. Despite these alterations, migratory bull trout persist in both local populations. Bull trout in this core area have diminished 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 Dungeness River core area have caused harm to, or harassment of, bull trout. However, many of these actions will provide long-term benefits to bull trout habitat. 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 HCPs addressing forest management practices. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Dungeness core area.

The number of non-Federal actions occurring in the Dungeness River 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 Dungeness River core area include the following:

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

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

- Water quality has been degraded by municipal, agricultural, and industrial effluent discharges and development.

- Residential and urban developments along the shore that include intertidal filling, bank armoring, and shoreline modifications have caused the loss of extensive eelgrass meadows in the nearshore.

- Bull trout are susceptible to incidental mortality associated with fisheries that target coho and steelhead at the mouth of the Dungeness River for approximately 74 days per year. Although recreational fishing for bull trout has been closed in the Dungeness River core area since 1994, incidental catch does occur, particularly during the early portion of the winter steelhead fisheries (NMFS, *in litt*. 2004).

- Predation by eagles and ospreys has caused the mortality of several fish in the Dungeness River that were tagged during the 2004 telemetry study (Ogg et al. 2008).

Elwha Core Area

The Elwha core area includes the Elwha River and its tributaries including Boulder, Cat, Prescott, Stony, Hayes Godkin, Buckinghorse, and Delabarre Creeks; Lake Mills and Lake Aldwell; and the estuary of the Elwha River. There is no upstream passage at either the Elwha Dam or Glines Canyon Dam, which fragment the core area. The Elwha River core area is one of two core areas in the Olympic Peninsula Management Unit that are connected to the Strait of Juan de Fuca.

Anadromous, fluvial, adfluvial, and resident life history forms likely occupy the Elwha core area. Until the recent Olympic National Park bull trout tracking and telemetry project, there was little available information on fish movement and life history expression. Spawning has now been documented in the area directly above Lake Mills. It is likely that additional spawning sites above Lake Mills occur although they have not yet been documented. There is little habitat suitable for bull trout spawning and incubation downstream from the dams. Elevated stream

temperatures in the mainstem Elwha River, due to the two dams and the lack of suitable tributary habitat, likely limit success of reproducing bull trout in both the lower and middle reaches of the Elwha River (S. Brenkman, pers.comm. 2007).

The status of a 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 (FWS 2004b).

Number and Distribution of Local Populations

Only one local population has been identified in the Elwha core area. Although bull trout have been documented throughout the upper Elwha, the recent telemetry project has identified several canyon reaches in the upper Elwha that may be complete or partial barriers to fish movement, and future surveys may identify additional local populations. The Little River has been identified as a potential local population, based on the availability of suitable habitat and the likelihood that this high quality spawning habitat will be available to migratory bull trout once the Elwha and Glines Canyon Dams are removed. With only one local population, bull trout in the Elwha core area are considered at increased risk of extirpation and adverse effects from random naturally occurring events.

Adult Abundance

Bull trout occur in moderately low numbers between the two dams. Both juvenile and adult bull trout have been captured in the upper and middle Elwha River and in Lake Aldwell below Glines Canyon Dam. At the time of listing, bull trout were rare (i.e., one or two fish per year) in the Elwha River below the Elwha Dam. Thirty-one bull trout, ranging in size from 250 to 620 millimeters, were documented in this section of the river during snorkel surveys in 2003 (G. Pess, NMFS, *in litt*. 2003). This number is likely related to increased survey effort rather than to an increase in numbers of bull trout in the lower Elwha River (S. Brenkman, Olympic National Park, pers.comm. 2007).

There is no information on trends in abundance of Elwha River bull trout, and the status of Elwha River bull trout is unknown. Consequently, until sufficient information is available regarding adult abundance, the bull trout population in the Elwha core area is considered at risk of genetic drift.

Productivity

There has been no monitoring of the bull trout in the Elwha River, and bull trout in the Elwha core area are considered at risk of extirpation until sufficient information is collected to properly assess productivity.

Connectivity

The Elwha and Glines Canyon Dams in the Elwha River fragment the populations of bull trout in the Elwha core area. Bull trout are found downstream of both dams, but there is no upstream passage. Restoration of connectivity in the Elwha River will be required to allow full expression of the bull trout's migratory life history forms, including anadromy. The dams are scheduled for removal in the future.

Changes in Environmental Conditions and Population Status

Since the bull trout listing, Federal actions occurring in the Elwha River core area have resulted in harm to, or harassment of, bull trout. 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 HCPs addressing forest management practices. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Elwha core area.

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

Threats

Threats to bull trout in the Elwha core area include the following:

- Two dams in the Elwha River prevent connectivity, increase injury and mortality of bull trout attempting to navigate through the dams, reduce spawning gravel recruitment, prevent recruitment of fluvially transported sediment to the estuary, affect the beach and eelgrass beds in the estuary, and increase water temperatures below the dams.

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

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

- Bull trout are susceptible to incidental mortality associated with fisheries that target commercially desirable species such as coho and steelhead.

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

4.0 STATUS OF BULL TROUT CRITICAL HABITAT (Rangewide)

Bull Trout

The action area is within the Coastal-Puget Sound Interim Recovery Unit (IRU) and includes that portion of the Puget Sound Management Unit (MU) that is encompassed by or connected to Puget Sound and that portion of the Olympic Peninsula MU encompassed by or connected to Hood Canal and the Strait of Juan de Fuca. Bull trout from 8 core areas that are connected to nearshore marine waters and 3 FMO areas outside of core areas will be affected by the proposed action. Bull trout from the following core areas are expected to be affected: Puyallup, Stillaguamish, Snohomish/Skykomish, Lower Skagit, Nooksack, Skokomish, Dungeness and Elwha Rivers. Areas outside of core areas will also be affected: Puget Sound, Hood Canal and Strait of Juan de Fuca. Unique to the Coastal-Puget Sound IRU, bull trout occur in marine nearshore waters and these areas support the complex migratory behaviors and requirements of the anadromous form of bull trout. As such, these areas are critical to the persistence of that life history form. Within the marine nearshore FMO areas, there is little or no documentation of bull trout in the marine waters of Puget Sound south of the Nisqually River, Hood Canal, Vashon Island, westside of Whidby Island, and the Kitsap Peninsula. It is considered unlikely or extremely rare for bull trout to be in those areas at this time. However, over the 50-year term of this HCP, in some areas adjacent to depressed populations, such as Hood Canal and the Skokomish core population, as the depressed core population recovers and increases in abundance, it is likely that those fish will expand their foraging area to again include the nearshore marine waters.

Hood Canal, Strait of Juan de Fuca and Puget Sound Marine Nearshore FMO

Anadromous adult and subadult bull trout utilize marine waters of the action area for FMO. In two recent telemetry studies documenting the extent of anadromy in bull trout within portions of the Coastal-Puget Sound IRU, approximately 55 percent of the fish tagged in freshwater emigrated to saltwater (Brenkman and Corbett 2005; Goetz et al. *in litt.* 2007). Results from these studies also demonstrate that anadromous bull trout inhabit a diverse range of estuarine, freshwater and marine habitats.

Marine waters provide important habitat for anadromous bull trout for extended periods of time. Data for bull trout from Puget Sound indicate that the majority of anadromous bull trout tend to migrate into marine waters in the spring and return to rivers in the summer and fall period. Although much less frequent, tagged fish have been detected in Puget Sound nearshore marine waters during December and January, which indicates that some fish remain in marine waters during the winter (Goetz et al. 2004b; U.S. Geologic Survey, *in litt.* 2008). It is thought that warmer water temperatures in the summer may be an environmental cue that stimulates bull trout to return to freshwater. Other factors that may influence marine residency for bull trout include prey availability, predation risks, or spawn timing.

In general, anadromous bull trout use shallow nearshore, subtidal, and intertidal waters. In two recent acoustic telemetry projects the greatest bull trout densities were at depths greater than 2.0 to 2.5 meters and can be found at depths as great as 25 m. (Goetz et al. 2005; U.S. Geologic Survey *in litt.* 2008). Upon entering marine waters bull trout can make extensive, rapid

migrations, usually in nearshore marine areas. During the majority of their marine residency, anadromous bull trout have been found to occupy territories ranging in size from ~10m to >3 km within 100-400m of the shoreline (U.S. Geologic Survey, *in litt.* 2008). Aquatic vegetation and substrate common to all or most bull trout areas includes eelgrass, green algae, sand, mud, and mixed fine substrates. These habitat features are also correlated with forage fish occurrence.

Some level of mixing or interaction within marine waters occurs among anadromous individuals from various core areas. Based on recent studies it is likely that bull trout from several core areas may be present within the action area simultaneously (Brenkman et al. 2007; Brenkman and Corbett 2005; Goetz et al. 2004a,b; Goetz et al. *in litt.* 2007). It is expected that within the action area individual bull trout from the Puyallup, Stillaguamish, Snohomish/Skykomish, Lower Skagit, Nooksack, Skokomish. Dungeness and Elwha Rivers are likely to be present. Thus the status of each of these core areas is discussed below. Most of the information for the status of the core areas was developed in our draft recovery plan, listing packages, the science information gathered for the bull trout 5-year review, and other recent documents that depict the baselines such as county and watershed or subbasin plans.

Bull Trout Critical Habitat

Status of bull trout critical habitat rangewide

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 Geoduck HCP action area (see **Action Area** description). Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the Geoduck HCP Action Area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

Status of Coastal-Puget Sound Critical Habitat Units in the Action Area

Critical habitat areas exposed to the effects of the action are all located within marine nearshore habitat. These nearshore marine waters are important for subadult and adult bull trout migration, forage, and refugia. Improving water quality and the function of critical habitat in these areas will require restoration efforts and complex negotiations.

Critical habitat for bull trout within the action area is designated in the inshore extent of marine nearshore areas (the MHHW line), including tidally influenced freshwater heads of estuaries. This refers to the average of all the higher high-water heights of the two daily tidal levels. The offshore extent of critical habitat for marine nearshore is based on the extent of the photic zone, which is the layer of water in which organisms are exposed to light. Critical habitat extends offshore to the depth of 33 ft (10 m) beyond the MLLW (average of all the lower low-water heights of the two daily tidal levels). This area between MHHW and -10 MLLW is considered the habitat used most consistently by bull trout in marine waters based on known use, forage fish availability, and ongoing migrations studies, and the area captures geological and ecological processes important to maintaining these habitats. The area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Primary Constituent Elements for Marine Nearshore Waters

Within the designated critical habitat areas, the primary constituent elements (PCEs) for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. The following PCEs apply to marine nearshore waters identified as critical habitat:

(i) Water temperatures that support bull trout use.

(vi) Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

(vii) An abundant food base including terrestrial organisms of riparian origin, aquatic macro invertebrates, and forage fish.

(viii) Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Critical Habitat Unit Status

Olympic Peninsula: Unit 27

Critical habitat has been designated in streams and rivers in all core areas within this unit and in the marine nearshore of the Pacific Ocean, Strait of Juan de Fuca, and Hood Canal. In the Elwha core area, critical habitat has also been designated in the Little River potential local population. Critical habitat has also been designated in the following FMO habitat outside of core areas: Bell, Cedar, Ennis, Goodman, Joe, Kalaloch, Morse, Mosquito, and Steamboat Creeks; Canyon, Chehalis, Copalis, Humptulips, Moclips, Satsop, and West Fork Satsop Rivers; and Grays Harbor, Hood Canal, Pacific Coast, and Strait of Juan de Fuca marine FMO habitats.

On the Olympic Peninsula, a significant portion of the major river basins, particularly the upper river portions where most bull trout spawning and rearing occurs, lie within the Olympic National Park. Spawning and rearing critical habitat has been designated in these areas within the Park. However, FMO critical habitat conditions are often degraded downstream of the park boundary (WSCC 2000, 2001). In the largely rural setting of the Olympic Peninsula, habitat effects are primarily related to past logging and associated roading and, to a lesser degree, dams and agricultural practices. Habitat conditions have improved to some extent over the past decade with more-protective forest practices and declining timber harvest on public lands. Although riverine migratory corridors are still functional, especially on the west side of the Olympic Peninsula, critical habitat conditions related to suitable temperatures, floodplain connectivity, substrate, timing and magnitude of flows, and habitat complexity related to large woody material have been degraded by historical land-management practices.

Critical habitat has also been designated in the marine nearshore of the Pacific Ocean, Strait of Juan de Fuca, and Hood Canal. Condition of the critical habitat in the Pacific Ocean has been impacted by roads and rural development. However human population density is low, there is

little industrial development, and the impacts to Pacific Ocean critical habitat are relatively minor. In Hood Canal extensive shoreline development has occurred, including diking and filling, shoreline armoring, and urbanization. Critically low dissolved oxygen (DO) levels have recently been observed in Hood Canal. Reasons for the low DO are unknown, but human activities and natural geography (e.g. excessive nutrient input, reduced freshwater input, low flushing rate) may be factors. Low DO zones have the potential to impede fish migration and forage fish health. In the eastern Strait of Juan de Fuca armoring occurs along 54 percent of the shoreline. Highway 101 is a significant constraint, and railroads follow much of the shoreline from Discovery Bay to Port Angeles. The damming of the Elwha River has reduced sediment loads to a portion of the central Straits and likely has accelerated erosion in some places. Shoreline development, urbanization, diking and filing, transportation related spills and discharges have impacted much of the marine nearshore and associated estuaries. A portion of PCEs 6, 7, and 8 within the designated critical habitat have been degraded, although the severity of degradation varies on a site specific basis.

Puget Sound: Unit 28

Critical habitat has been designated in streams and rivers throughout the Puget Sound Critical Habitat Unit. Critical habitat has also been designated outside of core areas in the marine nearshore waters of Puget Sound.

The urban rivers of Puget Sound have effects comparable to those on the Olympic Peninsula from past logging and logging roads in the upper reaches, but critical habitat has been further degraded in the lower floodplains. Intensive channelization to protect urban development and agricultural areas has resulted in permanent loss of floodplain functions in most of the lower rivers. The loss of riparian vegetation and increasing discharge of municipal and industrial wastewater and urban stormwater runoff has resulted in degraded water quality. The Washington Department of Ecology has placed a large number of waterways throughout Puget Sound on the 303(d) list of impaired waters. In addition to affecting water quality through flow alterations, hydroelectric dams block migration and have isolated bull trout populations in several core areas while water-control structures in the floodplains have effectively eliminated most of the estuaries and wetlands that historically provided rearing and foraging areas. Throughout Puget Sound shoreline development, urbanization, diking and filling, susceptibility to spills and discharges are stressors that have degraded critical habitat. Railroads follow portions of the shoreline and much of the shoreline is armored. Concentrations of commercial and recreational overwater structures such as ramps, piers and docks can be found in Tacoma and Commencement Bay, the Lower Duwamish River and Elliot Bay. *Spartina alterniflora* colonies are a concern in the Padilla/Samish Bay sub-basin, as they continue to try and take hold in the area. PCEs 6, 7 and 8 within the designated critical habitat have been degraded, although the severity of degradation varies on a site specific basis.

Conservation Role of Critical Habitat in the Action Area

The action area includes most of the Coastal-Puget Sound IRU, including the Puget Sound MU encompassed by and connected to Puget Sound and that portion of the Olympic Peninsula MU encompassed by and connected to Hood Canal and Strait of Juan de Fuca. The draft recovery plan states that maintaining viable populations of the bull trout is essential to the conservation of species within each of the core areas, IRU, and the coterminous listing (FWS 2004b). To maintain or restore the likelihood of long-term persistence of self-sustaining, complex, interacting groups of bull trout within the action area, the FWS has identified the following needs: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas; 2) maintain stable or increasing trends in abundance of bull trout; 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.

FMO areas are central to the survival and recovery of the bull trout. The draft recovery plan states that although use of FMO habitat by bull trout may be seasonal or very brief (as in some migratory corridors), it is a critical habitat element. The plan also states that bull trout need at least the following habitat conditions:

- Water temperatures ranging from -2 ºC to 22 ºC , depending on life history stage and form, geography, elevation, diurnal and seasonal variation, and local groundwater influence (PCE #1).

- Migratory corridors with no physical, biological or chemical barriers between spawning, rearing, overwintering, and foraging habitats (PCE #6).

- An abundant food base including prey items such as: macro invertebrates, crayfish, and forage fish (PCE #7).

- Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival, are not inhibited (PCE 8).

The intended recovery function of critical habitat is to support the core areas and ensure that the habitat requirements of bull trout are met, now and in the future. The primary constituent elements provide a measure of the habitat conditions and are essential components of critical habitat.

5.0 STATUS OF THE SPECIES: Coastal Cutthroat Trout – Rangewide

In 2000, the WDFW released its Salmonid Stock Inventory (SaSI) Coastal Cutthroat Trout (WDFW 2000) for Washington State. This inventory identified 40 “stock complexes” within Washington State. A stock complex is a group of stocks typically located within a single watershed, or other relatively limited geographic area, and believed to be closely related to one another (WDFW 2000). Of these 40 stock complexes, one was considered to be healthy, 7 were considered to be depressed and the status of the other 32 complexes was unknown (Table 5.1). The 7 depressed stocks are located in the lower Columbia River area (WDFW 2000).

Table 5.1 WDFW State Salmonid Inventory Coastal Cutthroat Trout Status Summary.

	Healthy	Depressed	Critical	Unknown	Extinct
Puget Sound					
North Puget Sound	**1**	**0**	**0**	**7**	**0**
South Puget Sound	**0**	**0**	**0**	**4**	**0**
Hood Canal	**0**	**0**	**0**	**2**	**0**
Strait of Juan de Fuca	**0**	**0**	**0**	**3**	**0**
Total	**1**	**0**	**0**	**16**	**0**
Coastal					
North Coast	**0**	**0**	**0**	**6**	**0**
Grays Harbor/Willapa Bay	**0**	**0**	**0**	**6**	**0**
Total	**0**	**0**	**0**	**12**	**0**
Columbia River					
Lower Columbia	**0**	**7**	**0**	**4**	**0**
Washington State					
40 Total Stock Complexes	**1**	**7**	**0**	**32**	**0**
Percent Total	**2%**	**18%**	**0%**	**80%**	**0%**

In 2002, FWS determined that the southwest Washington/Columbia River coastal cutthroat trout population was not warranted for listing under the Act. The most recent status assessments for coastal cutthroat trout in the Olympic Peninsula and Puget Sound areas is found in Johnson et al. (1999) status review (64 FR 16407) and in the 2000 Washington State Salmonid Stock Inventory: Coastal Cutthroat Trout (WDFW 2000).

The following status summary for the Action Area is largely based on information from those two reviews.

Puget Sound

Few data exist concerning historical and present abundance of coastal cutthroat trout in Puget Sound and almost no estimates of adult population sizes exist. Anecdotal reports suggest low abundance of coastal cutthroat trout in southwestern Puget Sound. NMFS concluded that population levels in Puget Sound appear to be relatively stable over the past 10 to 15 years, although many of the populations are believed to be smaller relative to historic levels. Juvenile coastal cutthroat trout are relatively well distributed in the Skagit and Stillaguamish River basins and along the Strait of Juan de Fuca.

Although trends in smolt numbers were mixed in both Hood Canal and southern Puget Sound, increases in smolt numbers in some urban streams coincided with declines in coho salmon abundance. In these streams it is possible that a relaxation of competition with coho has occurred, allowing for an increase in coastal cutthroat trout. To some degree cutthroat trout abundance is determined by interactions with sympatric species, particularly coho salmon. In developed urban watersheds, where alterations of natural flow patterns and water quality have occurred due to the expansion of storm water runoff, the changes in run-off patterns have put fall spawning salmonids at a disadvantage relative to spring spawners (Seiler et al. *in litt.* 2005). In these streams even moderate rainstorms become redd scouring torrents in the fall and winter. Furthermore, lack of wetlands and groundwater storage can result in extreme low summer flows. Because cutthroat trout spawn in the spring as flows are generally declining, their eggs survive at apparently much higher rates than those of coho. In these areas it appears that fall spawners, such as coho, are at a disadvantage to spring spawners, such as coastal cutthroat trout.

Olympic Peninsula

At the time of the 1999 status review, adequate information to estimate population abundances for coastal cutthroat trout in the Olympic Peninsula area was not available (Johnson et al. 1999). However, the review did find that limited trapping data support the opinions of State and Tribal fisheries biologist that juveniles in this area are well distributed in streams along the western Strait of Juan de Fuca and northern Washington coast. However, hatchery releases of coho salmon fry occur in some areas on the Olympic Peninsula, which may result in increased stress on coastal cutthroat trout due to elevated levels of inter-specific competition relative to what occurs naturally.

6.0 STATUS OF THE SPECIES: Marbled Murrelet – Rangewide

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 FWS recently proposed a revision to the 1996 murrelet critical habitat

designation (71 FR 44678 [July 31, 2008]). A final rule is expected in 2009. 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 FWS determined that the California, Oregon, and Washington DPS of the murrelet does not meet the criteria set forth in the FWS's 1996 DPS policy (61 FR 4722 [May 24, 1996]; U.S. Fish and Wildlife Service 2004). 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 address the objective of stabilizing the population size. To fulfill that objective, the Marbled Murrelet Recovery Plan (FWS 1997b) (Recovery Plan), focuses on protecting adequate nesting habitat by maintaining and protecting occupied habitat and minimizing the loss of unoccupied but suitable habitat (FWS 1997b: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 (FWS and NMFS 1998) and clarified by Memorandum (FWS 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 FWS'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 miles 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 (FWS 1997b).

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 (FWS 1997b). 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 (FWS 2004d), Oregon, and California (McShane et al. *in litt.* 2004).

Physical Description

The murrelet is taxonomically classified in the 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 (FWS 1997b).

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 (FWS 1997b).

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 6.1). 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 (Hamer et al. *in litt.* 2003).

Murrelets lay a single-egg clutch (Nelson 1997), which may be replaced if egg failure occurs early (Hebert et al. 2003; McFarlane Tranquilla 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 one to two 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 1995a). 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).

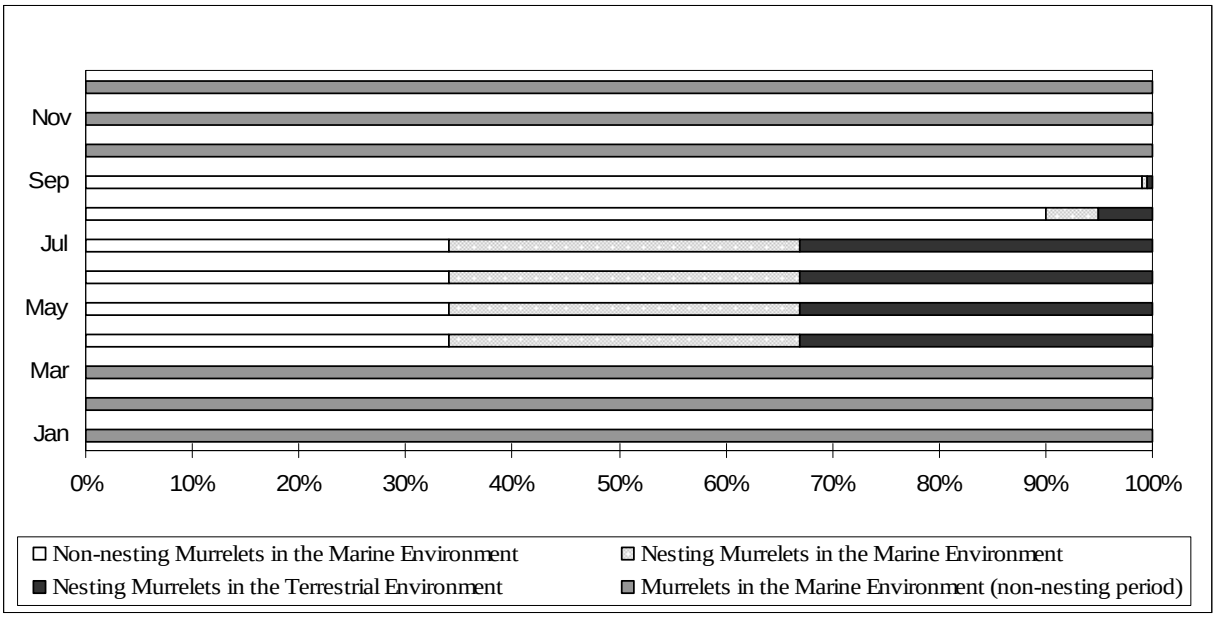

Figure 6.1 The seasonal changes in the relative proportion of breeding and non-breeding murrelets in the marine and terrestrial environments[1] within Washington State (Conservation Zones 1 and 2).

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).

[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.

MURRELETS IN THE MARINE ENVIRONMENT

Murrelets are usually found within 5 miles (8 kilometers) from shore, and in water less than 60 meters deep (approx. 180 feet) (Ainley et al. 1995; Burger 1995; Day and Nigro 2000; Nelson 1997; Raphael et al. 2007; Strachan et al. 1995). In general, birds occur closer to shore in exposed coastal areas and farther offshore in protected coastal areas (Nelson 1997). Courtship, foraging, loafing, molting, and preening occur in marine waters. Beginning in early spring, courtship continues throughout summer with some observations even noted during the winter period (Nelson 1997; Speckman 1996). Observations of courtship occurring in the winter suggest that pair bonds are maintained throughout the year (Nelson 1997; Speckman 1996). 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).

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 is 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 inter-specific feeding flocks (Strachan et al. 1995). Strong et al. (in 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 are wing-propelled pursuit divers that forage both during the day and at night (Carter and Sealy 1986; Gaston and Jones 1998; Henkel et al. 2003; Kuletz 2005). Murrelets typically forage in pairs, but have been observed to forage alone or in groups of three or more (Carter and Sealy 1990; Speckman et al. 2003; Strachan et al. 1995). 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) (Speckman et al. 2003; Strachan et al. 1995).

Murrelets can make substantial changes in foraging sites within the breeding season, but many birds routinely forage in the same general areas and at productive foraging sites, as evidenced by repeated use over a period of time throughout the breeding season (Becker 2001; Carter and Sealy 1990; Hull et al. 2001; Mason et al. 2002; Piatt et al. 2007; Whitworth et al. 2000). Murrelets are also known to forage in freshwater lakes (Nelson 1997). 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 (Ainley et al. 1995; Burger 1995; Nelson 1997; Speckman 1996; Strong et al. 1995).

Juveniles are generally found closer to shore than adults (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 Strachan et al. 1995) found that juveniles were more common within 328 ft of shorelines, particularly, where bull kelp was present.

Murrelets usually feed in shallow, near-shore water less than 30m (98 ft) deep (Huff et al. 2006), but are thought to be able to dive up to depths of 47 m (157 ft) (Mathews and Burger 1998). Variation in depth and dive patterns may be related to the effort needed to capture prey. Thick-billed murres (*Uria lomvia*) and several penguin species exhibit bi-modal foraging behavior in that their dive depths mimic the depth of their prey, which undergo daily vertical migrations in the water column (Butler and Jones 1997; Croll et al. 1992). Jodice and Collopy's (1999) data suggest murrelets follow this same pattern as they forage for fish that occur throughout the water column but undergo daily vertical migrations (to shallower depths at night and back to deeper depths during the day). Murrelets observed foraging in deeper water likely do so when upwelling, tidal rips, and daily activity patterns concentrate the prey near the surface (Strachan et

al. 1995).

The duration of dives appears to depend upon age (adults vs. juveniles), water depth, visibility, and depth and availability of prey. Murrelet dive duration ranges from 8 seconds to 115 seconds, although most dives last between 25 and 45 seconds (Day and Nigro 2000; Jodice and Collopy 1999; Thorensen 1989; Watanuki and Burger 1999).

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. *in litt.* 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 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)*, Pacific sardine (*Sardinops sagax*), juvenile rockfishes (*Sebastas* spp.) and surf smelt (Osmeridae) are the most common fish species taken. Squid (*Loligo* spp.), euphausiids, mysid shrimp, and large pelagic amphipods are the main invertebrate prey. Murrelets are able to shift their diet throughout the year and over years in response to prey availability (Becker et al. 2007). However, long-term adjustment to less energetically-rich prey resources (such as invertebrates) appears to be partly responsible for poor marbled murrelet reproduction in California (Becker and Beissinger 2006).

Breeding adults exercise more specific foraging strategies when feeding chicks, usually carrying a single, relatively large (relative to body size) energy-rich fish to their chicks (Burkett 1995; Nelson 1997), primarily around dawn and dusk (Kuletz 2005; Nelson 1997). 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). Becker et al. (2007) found murrelet reproductive success in California was strongly correlated with the abundance of mid-trophic level prey (e.g. sand lance, juvenile rockfish) during the breeding and post-breeding seasons. Prey types are not equal in the energy they provide; for example parents delivering fish other than age-1 herring may have to increase deliveries by to up 4.2 times to deliver the same energy value (Kuletz 2005). Therefore, nesting murrelets that are returning to their nest at least once per day must balance the energetic costs of foraging trips with the benefits

for themselves and their young. This may result in marbled murrelets preferring to forage in marine areas in close proximity to their nesting habitat. However, if adequate or appropriate foraging resources (i.e., "enough" prey, and/or prey with the optimum nutritional value for themselves or their young) are unavailable in close proximity to their nesting areas, marbled murrelets may be forced to forage at greater distances or to abandon their nests (Huff et al. 2006:20). 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, may affect reproductive success (Becker et al. 2007), and may significantly affect the energy demand on adults by influencing both the foraging time and number of trips inland required to feed nestlings (Kuletz 2005).

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. *in litt.* 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 (Hamer and Nelson 1995; McShane et al. *in litt.* 2004; Ralph et al. 1995). 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. *in litt.* 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. *in litt.* 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, 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 (Divoky and Horton 1995; Hebert et al. 2003; Manley *in litt.* 2000; Nelson 1997; Nelson and Peck 1995c). 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 is fewer because large, old-growth trees are rare (Manley 1999; Nelson and Peck 1995c; Singer et al. 1995).

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, Swartsman et al. (1997 in McShane et al. *in litt.* 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 *in litt.* 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 (16 km) in Prince William Sound, Alaska (McShane et al. *in litt.* 2004), 24 mi (38 km) in Desolation Sound, British Columbia, Canada (Hull et al. 2001), and 48 mi (76 km) in southeast Alaska. In California, Hebert and Golightly (*in litt.* 2003) found the mean extent of north-south distance traveled by breeding adults to be about 46 mi (77 km).

Murrelet nests have been located at a variety of elevations from sea level to 5,020 ft (1,530 m)(Burger 2002). However, most nests have been found below 3,500 ft (1066 m). 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 (1494 m) in the north Cascade Mountains (McBride, *in litt*. 2005). On the Olympic Peninsula, survey efforts for nesting murrelets have encountered occupied stands up to 4,000 ft (1219 km) within Conservation Zone 1 and up to 3,500 ft (1066

m) 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 (1097 m) 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 Northwest Forest Plan (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. *in litt.* 2004).

The development of the EM Program unified the various at-sea monitoring efforts within the 5 Conservation Zones encompassed by the NWFP. The highest total population estimate for this area (20,500 +/- 4,600 birds at the 95 percent confidence interval) was in 2004 and the lowest total population estimate (17,400 +/- 4,600 birds at the 95 percent confidence interval) was in 2007 (Gary Falxa, FWS, pers. comm. 2008). The most recent population estimate for Conservation Zone 6 is 400 birds (+/- 140 birds at the 95 percent confidence interval) (M.Z. Peery, Moss Landing Marine Lab, pers. comm. 2007).

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 1997a; Cam et al. 2003; McShane et al. *in litt.* 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. *in litt.* 2004). Two other more complex, unpublished models evaluate the effect of nest habitat loss on murrelets in Conservation Zone 4 (Akcakaya 1997; Swartsman et al. 1997; McShane et al. *in litt.* 2004). McShane et al. (*in litt.* 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. *in litt.* 2004). Table **6.**1 lists rangewide murrelet demographic parameter values from four studies all using Leslie Matrix models.

Table 6.1 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. *in litt.* 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 1997b

Regardless of model preference, the overall results of modeling efforts are in agreement, indicating murrelet abundance is declining (McShane et al. *in litt.* 2004:6-27). The rates of decline are highly sensitive to the assumed adult survival rate used for calculation (Beissinger and Peery *in litt.* 2003). The most recent modeling effort using the "Zone Model" (McShane et al. *in litt.* 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. (*in litt.* 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. *in litt.* 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 FWS 1997b). 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 FWS 1997b; Beissinger and Peery *in litt.* 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 FWS 1997b; McShane et al. *in litt.* 2004).

<u>Murrelets in Washington (Conservation Zones 1 and 2)</u>

Population estimates

Historically, murrelets in Conservation Zones 1 and 2 were "common" (Miller et al. 1935 in FWS 1997b; Rathbun 1915), "abundant" (Edson 1908; Rhoades 1893 in FWS 1997b), or "numerous" (Miller et al. 1935 in McShane et al. *in litt.* 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 2007 population estimate (with 95 percent confidence intervals) for Conservation Zone 1 is 7,000 (4,100 – 10,400) and Conservation Zone 2 is 2,500 (1,300 – 3,800) (G. Falxa, pers. comm. 2008). 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 were 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 (Bloxton and Raphael 2008) 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 2008) 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 regarding murrelet migration 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 of the amount of available suitable nesting habitat vary as much as the methods used for estimating murrelet habitat. McShane et al. *in litt.* (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. *in litt.* (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 FWS in 2005 resulting in an estimated 751,831 acres in Conservation Zone 1 and 585,821 acres in Conservation Zone 2 (Table 6.2).

Table 6.2 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 FWS 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 NWFP (Raphael et al. 2006). 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. (2006) 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. (2006) 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. (2006) 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 NWFP 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. 2006). 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. (2006) 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. (2006) 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 6.3). 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 6.3 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 (2006). All habitat estimates represent 1994-1996 values.

Because the HS >60 model performed best for capturing known murrelet nest sites, Raphael et al. (2006) 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. (2006), 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. (2006) 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. (2006) 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.

Conservation Zone 1

The majority of suitable murrelet habitat in Conservation Zone (Zone) 1 occurs in northwest Washington and is found on U.S. Forest Service (USFS) 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 (FWS 1997b).

Conservation Zone 2

Murrelet nesting habitat north of Gray's Harbor in Zone 2 occurs largely on State, USFS, 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]; U.S. Fish and Wildlife Service 1997a; Ralph et al. 1995; McShane et al. *in litt.* 2004). Activities, such as pile driving and underwater detonations, that result in elevated underwater sound pressure levels may also pose a threat to murrelets.

Prey Availability

Many fish populations have been depleted due to overfishing, reduction in the amount or quality of spawning habitat, and pollution. As of 2004, only 50 percent of the Puget Sound herring stocks were classified as healthy or moderately healthy, with north Puget Sound's stock being considered depressed and the Strait of Juan de Fuca's stocks being classified as critical (WDFW 2005a). Natural mortality in some of these stocks has increased (e.g. the mean estimated annual natural mortality rate for sampled stocks from 1987 through 2003 averaged 71 percent, up from 20 to 40 percent in the late 1970s) (WDFW 2005a). There is currently only one commercial herring fishery which operates primarily in south and central Puget Sound (WDFW 2005a) where herring stocks are healthier. Unfortunately, the decline of some herring stocks may be affecting the forage base for murrelets in Puget Sound. There is limited information available for the coastal herring populations, but these populations appear to have relatively high levels of abundance (WDFW 2005a). There are herring fisheries in Willapa Bay and Grays Harbor, but no direct harvest is allowed in the coastal waters.

While there are commercial and recreational fisheries for surf smelt, the amount of harvest does not appear to be impacting the surf smelt stocks (Bargmann 1998). There are no directed commercial fisheries for sand lance (Bargmann 1998). Anchovies are taken commercially within coastal and estuarine waters of Washington. While the current harvest level doesn't appear to be impacting anchovy stocks, there is no current abundance information (Bargmann 1998).

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. *in litt.* 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 species.

Oil Spills

Murrelet mortality from oil pollution is a conservation issue in Washington (FWS 1997b). 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). 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. *in litt.* 2004).

Since the murrelet was listed, the amount of oil tanker and shipping traffic has continued to increase (FWS 1997b; 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 million gallons of crude oil or refined petroleum products, but collectively, they carry about 15.1 billion gallons 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 will 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 (FWS 2005a). 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 (FWS 1997b; 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. *in litt.* 2004). Fishing effort has also decreased since the 1980s because of lower catches, fewer fishing vessels, and greater restrictions (McShane et al. *in litt.* 2004), although a resurgence 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 waters due to gill net mortality (McShane et al. *in litt.* 2004).

Entanglement in derelict fishing nets, which are nets that have been lost, abandoned or discarded in the marine environment, may also pose a threat. Derelict gear can persist in the environment for decades and poses a threat to marine mammals, seabirds, shellfish, and fish. A recent survey estimated 3,900 derelict nets need to be removed from Puget Sound annually (Northwest Straits Foundation *in litt.* 2007) and each year the number of new derelict nets increases faster than the number removed. Over 50 percent of the derelict nets in Puget Sound occur in waters where murrelet densities are the highest in Washington. Derelict fishing gear also occurs along the Washington coast and the outer Straits of Juan de Fuca. While this high energy environment may reduce the time a derelict net remains suspended compared to a lower energy environment like the inner Puget Sound where gear may persist for years (NRC *in litt.* 2007), the amount of time a derelict net poses a threat to marine species depends on the length and type of the net and cause of entanglement.

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. *in litt.* 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. *in litt.* 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; Nelson 1997; Speckman 1996). 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, movements, foraging efficiency, and overall fitness 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 (Cudahy and Ellison 2002; Fothergill et al. 2001; Popper 2003; Stevens et al. 1999; USDD 2002; Yelverton et al. 1973; Yelverton and Richmond 1981). 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 (Hastings and Popper 2005; Popper 2003; Turnpenny et al. 1994; Turnpenny and Nedwell 1994). 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 and Hamer Environmental 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 (Booth 1991; Perry 1995; Ripple 1994; Teensma et al. 1991). About 10 percent of pre-settlement old-growth forests remain in western Washington (Booth 1991; Norse 1990). 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. *in litt.* 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 (9,064 hectares) in Washington, Oregon, and California combined, of which 5,364 acres (2,171 hectares) resulted from timber harvest and 17,034 acres (6,893 hectares) resulted from natural events (McShane et al. *in litt.* 2004). The data presented by McShane et al. (*in litt.* 2004) 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. *in litt.* 2004). Raphael et al. (2006) 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. (2006) estimated that habitat loss ranging from 60,000 acres (24,281 hectares) up to 278,000 acres (112,553 hectares) 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. (2006) 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 (Beissinger 2002; USFS and BLM 1994b). 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. *in litt.* 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 (Nelson and Hamer 1995b; Ralph et al. 1995). Murrelets are believed to be highly vulnerable to nest predation compared to other alcids and forest nesting birds (FWS 1997b; Nelson and Hamer 1995b). 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 1995b). 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*) (Manley 1999; Nelson 1997; Nelson and Hamer 1995b). Predation by squirrels and mice has been documented at artificial nests and these animals cannot be discounted as potential predators on eggs and chicks (Bradley and Marzluff 2003; Luginbuhl et al. 2001; Raphael et al. 2002).

Losses of eggs and chicks to avian predators have been determined to be the most important cause of nest failure (McShane et al. *in litt.* 2004; Nelson and Hamer 1995b). 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 (McShane et al. *in litt.* 2004; Nelson and Hamer 1995b). For example, Nelson and Hamer (1995b) found successful nests were farther from edges (greater than 180 ft (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. *in litt.* 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. *in litt.* 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. *in litt.* 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 (Golightly et al. 2002; Long and Ralph 1998; Singer et al. 1995 in McShane et al. *in litt.* 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 (Beale and Monaghan 2004; Cairns 1980; Piatt et al. 1990; Pierce and Simons 1986).

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. *in litt.* 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 (McShane et al. *in litt.* 2004; Nelson and Hamer 1995b). 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 (Kitaysky et al. 2001; Marra and

Holberton 1998 in McShane et al. *in litt.* 2004; Wasser et al. 1997).

Although detecting effects of sub-lethal noise disturbance at the population level is hindered by the breeding biology of the murrelet, the effect of noise disturbance on murrelet fitness and reproductive success should not be completely discounted (McShane et al. *in litt.* 2004). In recently completed analyses, the FWS 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 (FWS 2003). These responses by individual murrelets to disturbance stimuli can reduce productivity of the nesting pair, as well as the entire population (FWS 1997b).

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 FWS estimates recovery of the murrelet will require at least 50 years (FWS 1997b).

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 (Beissinger and Peery *in litt.* 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) (Peery et al. *in litt.* 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

<u>Marine Environment</u>

Protection of marine habitat is 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 providing protection within marine waters in such a way as to reduce or eliminate murrelet mortality (FWS 1997b). The recovery strategy specifically recommends protection within all waters of Puget Sound and Strait of Juan de Fuca, and within 1.2 mi (1.92 km) of shore along the Pacific Coast from Cape Flattery to Willapa Bay. However, newer information indicates the majority of murrelet activity along the Washington coast occurs within 5 mi (8 km) of shore (Raphael et al. 2007), suggesting that protections should be extended to encompass this area. 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 (USDC 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) (FWS 1997b) relies heavily on the 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 HCPs, 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 (FWS 1997b).

Northwest Forest Plan

When the 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 BLM 1994a,b) 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 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 (USFS and FWS 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 HCP addressing murrelets in Washington have been completed for private/corporate forest land managers within the range of the murrelet: West Fork Timber Corporation (FWS 1995; Murray Pacific Corporation 1993, 1995) (Mineral Tree Farm HCP); Plum Creek Timber Company (FWS 1996a, 1999a; Plum Creek Timber Company 1996, 1999) (Cascades HCP; I-90 HCP); Port Blakely Tree Farms, L.P. (FWS 1996b; Port Blakely Tree Farms 1996) (R.B. Eddy Tree Farm HCP); and Green Diamond Timber Company (FWS 2000a; Green Diamond Timber Company 2000) (Olympic Tree Farm HCP). HCPs have also been completed for two municipal watersheds, City of Tacoma (FWS 2001; Tacoma Public Utilities 2001) (Green River HCP) and City of Seattle (City of Seattle 2001; FWS 2000b) (Cedar River HCP), and the Washington Department of Natural Resources (FWS 1997b) (WDNR 1997). 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 (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.

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 (Renwald pers. comm. 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 FWS 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 contribute to the current murrelet population decline throughout the coterminous United States.

7.0 STATUS OF THE SPECIES: California Brown Pelican – Rangewide

Legal Status

The brown pelican (*Pelecanus occidentalis californicus*) was federally listed as endangered in 1970 (35 FR 16047). The brown pelican recovery plan describes the biology, reasons for decline, and the actions needed for recovery of brown pelicans along the Pacific coast (FWS 1983). More recently, the FWS issued a 12-month petition finding and proposed rule to remove the brown pelican from the Federal list of threatened and endangered species (73 FR 9407). The State of Washington lists the brown pelican as State endangered. The brown pelican is one of six recognized subspecies of brown pelican worldwide.

Description and Behavior

The brown pelican is a large, stocky bird with a dark brown body and a massive bill and throat pouch. It is 45 to 54 inches high with a wingspan of 90 inches. Adult birds average 9 pounds in weight. The head is whitish as an adult, dark brown in juveniles. The brown pelican can be distinguished from the eastern subspecies by its larger size and its darker hindneck while in breeding plumage. Its eggs are slightly larger, as well (FWS 1983). The brown pelican usually rests its bill on its breast. Adults are silent, but young birds in nesting colonies are very vocal. Young brown pelicans generally go silent after fledging. Chicks are bare, brown, and leathery-

slick in appearance since they do not have down initially. Later, they will be covered with a silky down.

Adult brown pelicans are primarily fish eaters and require up to 4 pounds of fish per day. The brown pelican is an excellent diver plunging in pursuit of fish. Its pouch is used to separate the fish from the water. Their diet consists mainly of northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinopus sagax*), and other surface-schooling fish (Anderson et al. 1980, 1982; Anderson and Gress 1984). During the first nine weeks of its life, a brown pelican will eat 150 pounds of fish.

Adult brown pelicans may spend a considerable portion of the day on land and all congregate at night roosts during the non-daylight hours (Jaques and Anderson 1987). Pelican concentrations shift in response to prey distributions. The distance between suitable roost sites is influenced by the species' energy requirements, not only for shelter, thermoregulation, and plumage maintenance, but for efficient travel time to food resources (Jaques and Anderson 1987). Communal roosts may also provide increased protection from potential predators, act as centers for social facilitation of food finding, and possible other functions yet to be identified (FWS 1983). Brown pelicans are rarely found away from salt water and do not normally venture more than 20 miles out to sea.

Distribution

The brown pelican breeds in four distinct geographic areas: 1) Southern California Bight (SCB); 2) Gulf of California; 3) southwest Baja California coast; and 4) mainland Mexico (i.e., Sinaloa and Nayarit). Approximately 85-90 percent of the population breeds along the coast of mainland Mexico, southwest coastal Baja California, and in the Gulf of California; 10-15 percent of the population breeds in the SCB. The most recent population estimate of the brown pelican subspecies that ranges from California to Mexico along the Pacific Coast is approximately 71,200 nesting pairs, which equates to 142,400 breeding birds (Henny and Anderson 2007). Some genetic exchange occurs among colonies through the recruitment of new breeders. The largest breeding group is located on the Gulf of California, comprising approximately 68 percent of the total breeding population. Although two breeding colonies exist along the coast of California, the majority of brown pelicans seen foraging along coastal California likely come from Mexico, as those pelicans tend to be more mobile (del Hoyo et al. 1996).

Following the breeding season, brown pelicans may disperse from nesting colonies to areas as far away as British Columbia, southern Mexico, Oregon, Washington, and possibly, Central America. Post-breeding dispersal patterns depend largely on oceanographic conditions, which, in turn, influence food availability (Anderson and Anderson 1976). Birds that disperse northward from their breeding grounds are commonly seen diving for fish near the Oregon and Washington coasts.

Reproduction

Brown pelicans nest in colonies on small coastal islands that are free of mammalian predators and human disturbance and are associated with an adequate and consistent food supply. Nesting colonies of the brown pelican on the Pacific coast extend from the Channel Islands in the SCB,

south to the islands off Nayarit, Mexico. Prior to 1959, intermittent nesting was observed as far north as Point Lobos in Monterey County, California. Currently in southern California, brown pelican colonies are found only on Anacapa and Santa Barbara islands; they do not nest on any of the other Channel Islands. In addition, during 1996 and 1997 a small number of brown pelicans nested near Obsidian Butte at the Salton Sea.

The nesting chronology of brown pelicans varies from year-to-year, although most nesting activity occurs between February and October. Nesting may be synchronous or may consist of small colonies breeding asynchronously over a period of several months (FWS 1983). Brown pelicans lay two or three whitish eggs in a mass of sticks and grass placed in a tree, low bush, or on the ground on an island. Incubation takes about 30 days. Nesting habitat varies throughout the breeding range of brown pelicans. Commonalities among nesting habitats are islands free of human disturbance with steep, rocky slopes. Brown pelicans use whatever nesting material is available for nest building. Large nests (2 feet high) lined with grass and forbs are built in a tree, in a shrub or on the ground.

Foraging

While foraging, brown pelicans dive from 30 feet or more in the air, plunging headfirst into the water to catch fish. If successful, the birds separate water from fish and then they throw their heads back to swallow the prey. Brown pelicans feed and roost together, and nest in colonies. Groups of brown pelicans may be seen flying low over the waves or in loose formation at greater heights. Offshore habitat associated with island colony sites is also essential habitat for brown pelicans. Brown pelicans are dependent on food resources near the colony site during the breeding season. The offshore zone within 18 to 30 miles of the colony is critical to brown pelican food supplies, especially when young are being fed (Anderson and Gress 1984). Waters near colony sites are also important for wintering migratory birds and for newly-fledged young when they begin feeding for themselves. Offshore aquatic habitat, including the abundance and availability of brown pelican food resources, is a major factor in determining the population status of brown pelicans and the degree of breeding success (Chavez et al. 2003; FWS 1983).

Non-breeding

During the non-breeding season, which varies between colonies but typically extends from July to January, brown pelicans roost communally. Roosting sites and loafing areas are essential habitat for breeding brown pelicans and non-breeding local and migrants. Although they are seabirds, brown pelicans have wettable plumage so they must have terrestrial roost sites to dry wet plumage after feeding or swimming (Jaques and Anderson 1987). Roost sites are also important for resting and preening. The essential characteristics of a roost include: 1) nearness to adequate food supplies; 2) presence of physical barriers to predation and disturbance; 3) sufficient surface space for individuals to interact normally; and 4) adequate protection from adverse environmental factors such as wind and surf (Jaques and Anderson 1987). Offshore rocks and islands; river mouths with sand bars; and breakwaters, pilings, and jetties are some important roosting sites.

Population Status in the Coterminous United States

At the time the recovery plan was published (1983), it was estimated that the breeding population size throughout the range was approximately 55,000 to 60,000 pairs FWS 1983). This species declined considerably in the late 1960s attributed to the use of organochlorine pesticides, disturbance of nesting colonies, and over-harvesting of northern anchovies, the major food source. The ecological effects of DDT contamination have not been entirely eliminated, and incidences of eggshell thinning still occur. While low-level, chronic contamination remains, populations of brown pelicans in the southern California area have been increasing since the late 1970s. This population increase may be from outside recruitment and improved reproduction in local populations (Anderson and Gress 1984). In 2006, approximately 11,695 breeding pairs were documented at 10 locations in the SCB: 3 locations on Anacapa Island, 1 on Prince Island, and 1 on Santa Barbara Island in California; 3 on Coronados Islands, 1 on Islas Todos Santos, and 1 on Isla San Mart in Mexico within the SCB(73 FR 9407-9433).

Brown pelicans disperse from breeding colonies in late summer and move north and south along the coast. Birds begin to arrive on the Oregon and Washington coasts in June and their numbers peak in September. Their numbers gradually decline in October and early November as birds move south. Brown pelicans may be found along the outer coasts of Oregon and Washington from June to October.

Threats

Human Activities, Pollutants, and Contaminants

Although nest predation may be a problem, adult brown pelicans have few natural enemies. Nests are sometimes destroyed by hurricanes, flooding, or other natural disasters; however, the biggest threat to brown pelican survival has historically been related to human activities. Brown pelicans experienced widespread reproductive failures in the 1960s and early 1970s. Much of the failure was attributed to eggshell thinning caused by high concentrations of DDE, a metabolite of DDT. Other factors implicated in the decline of this species include human disturbance at nesting colonies and food shortages. Brown pelicans have not nested north of the Channel Islands since the species decline in the late 1950s and early 1960s. In 1972, the Environmental Protection Agency banned the use of DDT in the United States and placed restrictions on the use of other pesticides. Since then, the level of chemical contaminants in pelican eggs has decreased and brown pelican nesting success has subsequently increased. The brown pelican was the first species to apparently recover from the effects of pesticides.

Food availability, human disturbance at breeding and roosting sites, and chronic levels of DDT in the marine environment may still be suppressing productivity; however, brown pelican population numbers have increased steadily in the Southern California Bight (SCB; coastal southern California, from Point Conception south, including the Channel Islands and the local portion of the Pacific Ocean). After experiencing nearly complete reproductive failure during the late 1960s, with nesting attempts often numbering less than 1,000 per year until the late 1970s, brown pelican productivity started to improve following the ban on DDT. The increase in productivity that started in 1974 was correlated with an increase in eggshell thickness. Since 1974, food availability has become the most important limiting factor influencing brown pelican

breeding success within the SCB and both nesting attempts and productivity can fluctuate greatly year-to-year based on the availability of small surface-schooling fishes.

Global Climate Change/ Sea-Surface Temperature

Sea-surface temperatures have risen 1 degree Celsius over the past century and are expected to increase by up to another 3 degrees Celsius over the next 100 years if current trends continue (NWF 2007). Monitoring and planning for this increases in sea-surface temperature is needed, specifically for seabirds including the brown pelican.

8.0 STATUS OF THE SPECIES: Bald Eagle – Pacific Population

A detailed account of the taxonomy, ecology, and reproductive characteristics of the bald eagle is presented in the Pacific Bald Eagle Recovery Plan (FWS 1986), the final rule to reclassify the bald eagle from endangered to threatened in all of the lower 48 states (USDI 1994), and the proposed and final rule to delist the bald eagle (USDI 1999). The bald eagle was removed from the Federal List of Threatened and Endangered Wildlife, effective August 8, 2007 (USDI 2007). The most current information regarding bald eagles in Washington State and a detailed description of their biology and conservation can be found in the Washington State Status Report for the Bald Eagle (Stinson et al. 2001). A summary is provided below.

The bald eagle was federally listed in 1978 as an endangered species in all states except Michigan, Minnesota, Wisconsin, Washington, and Oregon, where it was designated as threatened (USDI 1978). The listing was a result of a decline in the bald eagle population throughout the lower 48 States. The decline was largely attributed to the widespread use of dichloro-diphenyl trichloro-ethane (DDT) and other organochlorine compounds, in addition to habitat loss, disturbance, shooting, electrocution from power lines, poisoning, and a decline in the food base.

The bald eagle was reclassified in 1995 from endangered to threatened as a result of a significant increase in the number of nesting pairs, increased productivity, and expanded distribution (USDI 1994). Since 1989 the bald eagle nesting population has increased at an average rate of approximately 8 percent per year (USDI 1999). The national average for fledglings per occupied breeding area is greater than one; therefore, the bald eagle population continues to increase. Certain geographically restricted areas, such as southern California, the Columbia River, the Great Lakes, and parts of Maine still have contaminant threats (USDI 1999). However, bald eagle recovery goals have generally been met or exceeded throughout its range (USDI 1999). The bald eagle was removed from the Federal List of Threatened and Endangered Wildlife, effective August 8, (USDI 2007). The protections provided to the bald eagle under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act continue to remain in place.

The delisting goals for the Pacific Recovery Area include: 1) a minimum of 800 nesting pairs; 2) an average reproductive rate of 1.0 fledged young per occupied breeding area, with an average success rate for occupied breeding areas of not less than 65 percent over a 5-year period; 3) breeding population goals attained in at least 80 percent of management zones; and 4) wintering populations which are stable or increasing (FWS 1986).

In the Pacific Recovery Area population delisting goals have been met since 1995, the productivity objective of an average of 1.0 young per occupied breeding area has been met since 1990, and the average success rate for occupied breeding areas of 65 percent has been exceeded since 1994 (USDI 1999). However, as of 1999, the distribution objective among management zones had not yet been fully achieved.

Of the seven states covered in the Pacific Recovery Area, Washington State supports the largest breeding and wintering populations (FWS 1986). In 2001, 684 nest territories were occupied in Washington (WDFW *in litt.* 2003). Most nesting territories in Washington are located on the San Juan Islands, along the coastline of the Olympic Peninsula, along the Strait of Juan de Fuca, Puget Sound, Hood Canal, and the Columbia River. Wintering concentration areas in Washington are along salmon spawning streams and waterfowl wintering areas (Stinson et al. 2001).

Conservation Needs of the Bald Eagle in Washington

Habitat

Nesting and wintering habitats are critical to the continued survival of the bald eagle (USDI 1999). Development-related habitat loss has been a significant threat to bald eagles in the Pacific Recovery Area of Washington, Idaho, Nevada, California, Oregon, Montana, and Wyoming (USDI 1994), although availability of habitat does not appear to be limiting bald eagle populations at this time (USDI 1999). Urban and recreational development, logging, mineral exploration and extraction, and other forms of human activities can adversely affect the suitability of breeding, wintering, and foraging habitat for bald eagles. While individual and small-scale actions may not appear to significantly affect the species as a whole, the cumulative long-term effects throughout the recovery area pose an important threat to the recovery of the species (USDI 1999).

Availability of suitable trees for nesting and perching is critical for maintaining bald eagle populations. The primary objective of the bald eagle recovery process is to provide secure habitat for bald eagles within the recovery area, and to increase population levels in specific geographic areas. Achieving and maintaining the recovery goal of increasing the number of nesting pairs within the recovery area requires protection of existing habitat for breeding and wintering bald eagles, and restoring habitat that has been lost due to development or habitat modification.

Nesting Habitat

Suitable habitat for bald eagles is characterized by accessible foraging areas and trees that are large enough for nesting and roosting (Stalmaster 1987). Food availability, such as aggregations of waterfowl or salmon runs, is a primary factor attracting bald eagles to wintering areas and influences nest and territory distribution in Washington (Keister et al. 1987; Stalmaster 1987).

Bald eagles generally nest in the same territories each year and often use the same nest repeatedly, although alternate nests in the territory may be used as well. Bald eagle nests in the

Pacific Recovery Area are usually located in uneven-age stands of coniferous trees with old-growth forest components (FWS 1986) that are located within 1 mile of large bodies of water (Stalmaster 1987). Factors such as relative tree height, diameter, tree species, tree form, position on the surrounding topography, distance from the water, and distance from disturbance influence nest site selection. Anthony and Isaacs (1989) found that bald eagles construct nests in Douglas-fir (*Pseudotsuga menziesii*) or Sitka spruce *(Picea sitchensis*) trees with an average diameter of 170.7 centimeters (67.2 in) diameter breast height (DBH) and a height of 56.6 meters (186 feet) in Douglas-fir forests, and an average diameter of 106.8 cm (42 inches) DBH and a height of 38.6 m (127 feet) in mixed-conifer forests. Suitable perch trees, which bald eagles use for guarding the nest, loafing, and foraging, are also a component of suitable nesting habitat (Buehler 2000; Stalmaster 1987).

Wintering Habitat

Wintering bald eagles typically congregate in large aggregations where, most importantly, food is abundant. Suitable perch sites adjacent to foraging areas and winter roost habitat are also necessary. In Washington, these criteria are typically met where waterfowl and salmon populations are present, as well as marine areas (Stinson et al. 2001).

When foraging, bald eagles select perches that provide an unobstructed view of the surrounding area, generally the tallest trees in the area. Tree species commonly used in Washington for perching in winter include black cottonwood (*Populus trichocarpa*), bigleaf maple (*Acer macrophyllum*), Douglas-fir, or Sitka spruce (Stalmaster and Newman 1979).

Wintering bald eagles often roost at communal sites which provide shelter during inclement weather. Bald eagles may roost communally in single trees or large forest stands of uneven ages. Bald eagles may remain at their daytime perches throughout the night as well, but typically gather at large communal roosts in the evening.

Communal night roosting sites are traditionally used year after year. Roost trees are usually the largest and have the most open structure (Keister and Anthony 1983; Watson and Pierce 1998a). They are often located in areas that provide a more favorable microclimate during inclement weather (Keister et al. 1985; Knight et al. 1983; Watson and Pierce 1998a). Prey sources may be available in the general vicinity, but for roosting, close proximity to food is not as critical as the need for shelter. In Washington, 26 roosts studied by Watson and Pierce (1998a) were all within

1,100 m (3,609 ft) of foraging areas. However, Stalmaster (1987), in reviewing a variety of studies found that only 40 percent were within 1 kilometer (0.6 mi) of water.

Human Disturbance

Human disturbance is a continuing threat, which may increase with increasing human populations and development (UDSI 1999). Bald eagles vary in their sensitivity to disturbance, but generally nest away from human disturbance (Stinson et al. 2001). However, distance, duration, visibility and position of an activity affect bald eagle response, with distance being the most important factor (Grubb et al. 1992; Grubb and King 1991; Watson 2004). The response of

nesting bald eagles to human activity can range from behavioral, such as flushing, or reduced nest attendance, to nest failure (Anthony et al. 1995; Fraser et al. 1985; Grubb et al. 1992; Grubb and King 1991; McGarigal et al. 1991; Steidl and Anthony 1996; Watson and Pierce 1998a). Wintering bald eagles may also be displaced from foraging areas by human activities (Stalmaster and Newman 1978; Stalmaster and Kaiser 1998). The magnitude of response varies inversely with distance, and increases with disturbance duration, the number of vehicles or pedestrians per event, visibility, sound, and position in relation to nest (above, at eye-level, or below the nest) (Grubb and King 1991; Watson 2004). Watson and Pierce (1998a) found that vegetative screening and distance were the two most important factors determining the impact of disturbances. Heavy vegetative screening can dramatically reduce bald eagle response to human activity. Human activities that are distant, of short duration, out of sight, few in number, below the nest, and quiet have the least impact (Grubb and King 1991; Watson 2004).

The effects from disturbance to nesting bald eagles vary, depending on the stage of nesting. In western Washington most bald eagles engage in courtship behavior in January and February, and begin to incubate their eggs by the third week in March. Young hatch by late April, and generally fledge during early to mid-July (Watson and Pierce 1998a). Anderson (1990) found in red-tailed hawks (*Buteo jamaicensis*), as well as in his review of other studies, that adults were more defensive as the parental investment in the young increased (and were therefore less likely to leave the nest unattended or abandon the nest). The natural exposure time from incubation to brooding also naturally increases (Watson and Pierce 1998a), and the bald eaglets began to thermo-regulate at the age of 15 days (Bortolotti 1984), indicating that bald eaglets would be less affected by disruption of adult nest attendance as the nesting season progresses.

Contaminants

Contaminants, in particular organochlorine compounds such as DDT, are recognized as one of the primary causes of the decline of bald eagle populations (FWS 1986; USDI 1999). DDT was banned, and registrations cancelled for other toxic persistent chemicals such as dieldrin, heptachlor and chlordane for all but the most restricted uses. The use of polychlorinated biphenyls (PCBs) has also been phased out. The reduction of these chemicals in the environment has resulted in a reduction of these levels of contaminants in bald eagles and a steady increase in bald eagle numbers (Schmitt and Bunck 1995). However, residues of PCBs and Dichloro-diphenylethylene continue to depress productivity in certain locations such as the Channel Islands in California, the Great Lakes and the lower Columbia River (USDI 1999). Bald eagles continue to be affected by accumulated chemicals such as mercury (USDI 1999), as well as poisoning by lead, organophosphorus, and carbonate (Franson et al. 1995).

Foraging

An important component of bald eagle nesting and wintering areas is a consistent source of food. Fish and waterfowl are typically the most important food resource (Stalmaster 1987). Coastal and estuarine areas also provide abundant prey resources, including seabirds and marine invertebrates (Watson et al. 1991; Watson and Pierce 1998b). The availability of food resources is critical during brood rearing, when food limits survival of young (Stalmaster 1987).

Food resources govern the distribution of bald eagles in the winter. In Washington, salmon carcasses, particularly those of chum salmon (*Oncorhynchus keta*), are the most important food source (Watson and Pierce 2001). Because survival of bald eagles in their first year is typically low (Stalmaster 1987), winter food availability is important for survival. Stalmaster and Kaiser (1998) and Hansen and Hodges (1985) have also suggested that winter food shortages or disrupted winter foraging may result in reduced reproductive rates.

9.0 STATUS OF THE SPECIES: Tufted Puffin – Rangewide

Legal Status

The tufted puffin (*Fratercula cirrhata*) is a Species of Concern by the Western Washington Fish and Wildlife Office. The tufted puffin is also listed as a Washington State candidate species by the WDFW. Its cause of decline is unknown but is thought to be largely due to nesting habitat loss, containments, prey availability, predation, and disturbance. This includes high nest-site predation rates and human-induced mortality in the marine environment from gillnets and oil spills.

Life History

Tufted puffins are spectacular in appearance particularly with their chunky orange bill. This bill and their unexplained habit of circling and investigating vessels at sea helps make this "sea parrot" among the most well known of seabirds (Speich and Wahl 1989).

Physical Description

The tufted puffin is taxonomically classified in the Alcidae, a family of Pacific seabirds. This large alcid is similar in size to a crow with an average wingspan of 38 cm (15 inches) and an approximate length of 40 cm (15.7 inches), but is twice as heavy with short stubby wings and an approximate weight of 775 grams (1.7 lbs)(FWS 2006; Piatt and Kitasky 2002). The tufted puffin is adapted for its marine and land lifestyle possessing both the ability to dive under water using wing-propulsion in the pursuit of food as well as the ability to walk upright with ease over rocks, clinging to the surface with claws while reclining with its tarsus pressed flat (Piatt and

Kitaysky 2002). The sharp claws on their webbed feet are also used to dig burrows in the steep hillsides of their nesting areas (FWS 2006). Its short neck retracts into its shoulders for flight.

Tufted puffins are highly decorative seabirds. In the winter, as puffins prepare for spring breeding, their colors become more pronounced, presumably to attract mates. During this time of alternate-plumage they develop a brownish-black body, with white feathers lining the underside of the wing, a white face, and glossy yellow plumes above and behind the eye. The bill is mostly bright red, with yellow and sometimes green markings. When breeding ends in the early summer, puffins return to their basic-plumage by losing their plumes, the bright colors of the bill turn to a dull reddish-brown, and the belly is speckled with some pale brown flecks. Their legs and feet are red or orange-red throughout the year. Males are slightly larger than females, but the sexes otherwise are alike in appearance. Juvenile puffins are similar in color to basic-plumage adult puffins, but with a grey-brown breast, white belly, and a shallow, brown bill (Gabrielson 1970; Gaston and Jones 1998; Piatt and Kitaysky 2002).

Juvenile and basic-plumage tufted puffins may be confused with the small, slimmer billed, pale belly rhinoceros auklet (*Cerorhinca monocerata*), however, the tufted puffin in these plumages usually show broad grayish streak behind the eye. The tufted puffin is distinguished from the similar-sized murres (*Uria* spp.) and horned puffin (*Fratercula corniculata)* by its dark breast in all plumages and from horned puffin also by its head plumes and a lack of yellow in the bill during the breeding season (Piatt and Kitaysky 2002).

Distribution

Tufted puffins are North Pacific sea birds that spend a majority of the year over the Pacific Ocean (Figure 9.1), but nest along coastlines and offshore islands in California, Oregon, Washington, British Columbia, Alaska (Gulf of Alaska and the Aleutian Islands), the Bering and Chukchi Seas, and Japan to the shores of northeastern Asia (Gaston and Jones 1998; Piatte and Kitaysky 2002). The tufted puffin winters over a broad area of the North Central Pacific, generally over deep oceanic waters (Piatt and Kitaysky 2002).

Figure 9.1 North Pacific Ocean
NOAA 9/25/06

Reproduction

Tufted puffins return to colonies the same time each year (Ainley and Boekelheide 1990). These alcids are socially monogamous (Harris 1984) and arrive at breeding grounds in pairs or meet their mate shortly after arrival to engage in intense courtships and frequent copulations (Wehle 1980). Mating occurs mostly on the water and less so at the actual colony site (Mikhtaryantz 1977). Puffins occupy nesting habitat about 1 week after arrival (Wehle 1976). Breeding usually begins in April, although mating activity has been seen as early as March and as late as May in some cases. Timing varies and is probably related to food production and/or accessibility of nesting habitat as one goes north (Wehle 1980).

Each female puffin lays one off-white egg, sometimes with faint blue and brown markings, usually between late April and early June but egg production may be delayed with an increase in latitude (Gaston and Jones 1998). Eggs produced later than June are unlikely to produce fledglings. Females often lay replacement eggs if the first egg is lost early in the breeding season (Ainley and Boekelheide 1990). The peak egg-laying period usually lasts about two weeks in each colony. Both parents help with incubation, which lasts between 40 and 53 days (Gaston and Jones 1998; Kessel 1989; Paul et al.1994). The chick hatches, usually around late June to early July, in which its growth rate is variable depending on the feeding conditions at the colony's location. Both parents take turns bringing food to the chick, which happens two to three times daily, and most frequently in the morning and early evening. The chick broods for the first 5 to 7 days, after which it is left alone during the day while the parents forage (Gaston and Jones 1998). A chick remains in the burrow and relies on its parents until fledged, which usually happens in late July through August, 45 to 55 days after hatching. The chick is completely independent of parents after fledging (Piatt and Kitaysky 2002). There is no post-fledging parental care, and the puffin first leaves the nest for the open sea alone at night. Young

puffins usually do not return to the colony for almost two years, spending all their time at sea. Puffins become sexually mature at the age of three, but most do not mate until the age of four (Gaston and Jones 1998; Kessel 1989; Paul et al. 1994).

Nesting site

Tufted puffins excavate burrows (Gaston and Jones 1998) though they also nest in rock crevices and nest boxes (Johnsgard 1987). Burrows are generally found in steep, sea-facing slopes (Vermeer 1979). They will nest in less-steep terrain, where they usually do not overlap with the smaller rhinoceros auklets. Burrow densities appear highest along cliff edges, steep slopes covered with vegetation, and deep layers of soil (Amaral 1977; Vermeer 1979), while lower densities are found in rock-crevice habitats, among beach boulders, and in cracks and crevices of sea cliffs. Occasionally puffins nest on open ground under bushes (Bent 1919), in bunches of grass (Mikhtaryantz 1977), or in sandy burrows on estuarine islets. Tufted puffin pairs defend a territory that includes the burrow entrance, a path to the burrow, and a landing area (Johnsgard 1987). Puffin pairs usually use the same nest site annually (Ainley and Boekelheide 1990; Gaston and Jones 1998; Johnsgard 1987).

Behavior

Locomotion

On land the tufted puffin walks upright on its toes with ease and is also capable of hopping. In flight it uses its feet as rudders and often crashes into tall grass, rocks, and talus slopes during landing. When departing from the colony, it uses the slope and elevated rocks or cliffs to initiate flight (Mikhtaryantz 1977). Take off from the water includes gathering momentum, sometimes using feet as paddles until airborne. The tufted puffin swims on the water's surface by paddling with its feet. It is a powerful underwater swimmer and diver and propels itself underwater by using flightlike beating of half-opened wings (Piatt and Kitaysky 2002) capable of reaching depths of over 100 meters (328 feet)(Ainley and Boekelheide 1990).

Self maintenance

There are three types of tufted puffin body maintenance behavior as per Wehle (1980): 1) head-dipping during swimming with head-shaking to eliminate water; 2) wing-flapping when the puffin vigorously flaps its wings and fluffs its feathers sometimes also after bathing; and 3) preening including rubbing the side of its bill on the uropygial gland and using the secretion on its feathers for waterproofing and maintenance.

Social and Courting

Tufted puffins are less social and more dispersed at sea than other species of puffins. They nest solitarily, as well as in large mono- and multi-species colonies (Piatt and Kitaysky 2002). Social

and territorial behavior includes landing displays and fly-by displays. Fly-bys during breeding season include circular flights above breeding colony before landing (Wehle 1980).

Puffin courting behavior includes skypointing (flying straight upwards), strutting, and billing (two birds rubbing their bills together) (Gaston and Jones 1998; Kessel 1989; Paul et al. 1994), Also during this time the male puffin stretches and lifts his neck and "jerks" his head in a fast motion, as well as opens and closes his bill to expose the female to his bright attractive mouth-lining and pink rosettes in the corners of his mouth (Amaral 1977).

Vocalization

Tufted puffins have a limited range of calls, including a low grumbling noise heard usually from underground in breeding colonies. Chicks often peep to indicate that they want food (Gaston and Jones 1998).

Molting

Juveniles molt during their first winter at sea, and again the following autumn. Adult puffins molt completely following the breeding season, and partially before breeding. (Gaston and Jones 1998; Kessel 1989; Paul et al. 1994)

Foraging

Puffins generally forage alone, but sometimes in monospecific or mixed species assemblages (Hoffman et al. 1981). Most feeding occurs within 15 meters (49 feet) of the sea surface (Wehle 1980). Ostrand (1998) states that tufted puffins select fish schools near their colony but do not show a preference for shallower water, suggesting the tufted puffin foraging is not constrained by water depth. Tufted puffins, therefore, depending on colony location, may forage in inshore or offshore waters (Kessel 1979; Wehle 1980) and in offshore waters during the winter. Adults can carry 12 fish or more, crosswise in their bills, when feeding chicks (Speich and Wahl 1989). Parents can range far from breeding colonies on foraging excursions (Gaston and Jones 1998; Johnsgard 1987) and return to feed chicks three times a day (Gaston and Jones 1998; McChesney et al. 1995).

Prey Species

Wehle's (1980) study, in which the stomach contents of 120 adult and 15 subadult tufted puffins were analyzed, showed fish, squid, and polychaetes as the most common prey type. This is typical for the non-breeding season, but usually during the breeding season tufted puffin's prey base is solely small schooling fish such as anchovy (*Engraulis mordas*), capelin (*Mallotus villosus*), lanternfish (especially Myctophidae), juvenile pollock (*Theragra chalcogramma*), rockfish (*Sebastes* spp.), greenling (Hexagrammidae), and sandlance (*Ammodytes hexapterus)* (Piatt and Kitaysky 2002). Chicks are fed almost exclusively fish (Gaston and Jones 1998; Johnsgard 1987) with the largest prey and the highest protein and energy values (Baird 1991).

Predators

Avian predators of the tufted puffin include bald eagles (*Haliaeetus leucocephalus*), peregrine falcons (*Falco peregrinus*), snowy owls (*Nyctea scandiaca*), and eagle owls (*Bubo bubo*). Large gulls (family Laridae) and ravens (*Corvus corax*) occasionally prey on eggs and chicks (Wehle 1980). Because tufted puffins nests in accessible burrows, chicks and eggs all have been historically affected by the introduction of mammalian predators including the arctic (*Alopex lagopus*) and red (*Vulpes vulpes*) fox, and the Norway rat (*Rattus norvegicus*). Eggs and young are also taken in their burrows by river otters (*Lutra canadensis*) and mink (*Mustela vision*) (Gaston and Jones 1998).

Population Status in the Coterminous United States

Population Abundance

Total tufted puffin population numbers are unknown due to the difficulty of censusing seabirds. Most estimates are based on the observations of birds attending colonies, with some estimates from counts of birds on the water. The total world population estimate is 2,971,260 birds taken from Piatt and Kitaysky (2002). Eighty-two percent (2,441,120 numbers of individuals) of the population estimate is in North America (Table 9.1). Piatt and Kitaysky (2002) include the statistics of the North American tufted population mentioning a range of population percentages including population/percentage of individuals in California (0 - 0.01 percent), Oregon (0.2 percent), Washington (0.8 – 0.9 percent), and British Columbia (2.6 – 3.1 percent). The remainder of the population is lumped into Alaska, with the largest concentrations of individuals in the Gulf of Alaska (32.1 - 36 percent), in the Aleutian Islands (42.8 - 45 percent), and tufted puffin populations in the Bering (4 - 4.6 percent) and Chukchi (0 - <0.01 percent) seas.

In Washington, the Puget Sound Ambient Monitoring Program (PSAMP)[2] performed an overview of species distribution and abundance from aerial surveys for the summers and winters 1992 through 1999. Surveys were extended in 1993 to include the western portion of the Strait of Juan de Fuca. The proportion of summer tufted puffin for this time period was less than 0.1 percent of an annual density average of 87 birds per square kilometer. Species composition in winter changed from that seen during the summer with the departure of tufted puffins (Nysewander et al. 2005).

[2] PSAMP implements monitoring plans for marine birds, waterfowl, and marine mammals.

Table 9.1 Tufted puffin colonies and populations in the North Pacific

Country	State/Province/ Area	Number of colonies	Number of individuals	Percentage of colonies	Percentage of individuals
U.S.	California	13	280	1.3	0.0
	Oregon	31	5030	3.0	0.2
	Washington	16	22,300	1.6	0.8
	Gulf of Alaska	447	952,330	43.4	32.1
	Aleutian Islands, AK	167	1,271,800	16.2	42.8
	Bering and Chukchi seas	97	112,650	9.4	3.8
Canada	British Columbia	31	76,730	3.0	2.6
TOTAL North America		**802**	**2,441,120**	**77.8 (*77.9*)**	**82.2**
Russia		224	530,110	21.7	17.9
Japan		5	30	0.5	0.0
TOTAL Asia		**229**	**530,140**	**22.2**	**17.8**
TOTAL World		**1,031**	**2,971,260**	**100 (*100.1*)**	**100 (*100.1*)**

Table taken from Piatt and Kitaysky 2002 (Data in table compiled from Alaska and Russia-Beringian Seabird Colony Atlas, FWS, Anchorage, AK, and Kondratyev et al. 2000)

Population Trend

Census data were collected and a comparison of population trends was done by Piatt and Kitaysky (2002) in which their results suggested tufted puffin populations are increasing in the Gulf of Alaska and westward, and declining throughout Alaska, British Columbia, Washington, Oregon, and California (Table 9.2). They also noted that these patterns may resemble the salmon (*Oncorhynchus* spp.) and steller sea lion (*Eumetopias jubatus*) trends and the Westwind Drift Current[3] trends (Piatt and Kitaysky 2002, Francis et al. 1998).

[3] Also referred to as the Antarctic Circumpolar Current in which surface oceanic currents encircle Antarctica, flowing from west to east.

Table 9.2 Population trends of tufted puffins in North America.

Country	State/Province	Location	Population Change % Annum
U.S.	Alaska	W. Aleutians	+5.6, +8.7, +6.8
		Central Aleutians	+17.9
		E. Aleutians	+3.2, +2.5
		N. Gulf of Alaska	+3.2, +3.9
		SE Alaska	-5.9
	Washington	Strait of Juan de Fuca/ Protection Island	-13.9
		N. Coast/Tatoosh Island	-16.9
		S. Coast/Westport	-13.6
	Oregon	Outer Coast/Three Arches Rock	-3.6
	California	N. Coast/Castle Rock	-6.3
		Central Coast/Farallon Island	-3.4
Canada	British Columbia	S. Queen Charlotte Island	-10.6
		N. Vancouver Island	-1.0

Table taken from Piatt and Kitaysky 2002.

Tufted puffins population and nesting colonies in Washington

In Washington, two sources of continuous long-term data suggest marked declines in the tufted puffin population during the past 20 years (Table 9.2). This data is separated out into Conservation Zone 1 (Strait of Juan de Fuca/ Protection Island) and Conservation Zone 2 (North Coast/Tatoosh Island and South Coast/Westport).

Conservation Zone 1: Washington's Puget Sound, San Juan Islands, Strait of Juan de Fuca

Puget Sound

Tufted puffins and their nesting colonies are absent in the South Puget Sound and the Hood Canal. In the North Puget Sound, which includes the waters between the Strait of Juan de Fuca and the San Juan Islands, tufted puffins are observed swimming and foraging. A tufted puffin colony existed on Smith Island in the past, and may still exist (Ryan, Kevin, San Juan Islands National Wildlife Refuge, pers. comm. 2006; Speich and Wahl 1989). As per Piatt and Kitaysky (2002), the Smith Island population declined from a historic high of 500 tufted puffins to 0 in 1986, but six were sighted in 2001.

Strait of Juan de Fuca

Tufted puffin populations are severely reduced within sheltered inside waters of the Strait of Juan de Fuca, including Protection Island where there is a nesting colony. Historically tufted puffins numbered 400 individuals in this area, but were reduced to approximately 100 birds in the late 1970s, 74 birds in 1986, and 19 birds in 2001 (Speich and Wahl 1989). Trends for Protection Island since 1973 is -13.9 percent population change annually (Table 9.2) and about -

9.4 percent population change annually during the past 15 years (Piatt and Kitaysky 2002). Speich and Wahl (1989) observed tufted puffin colonies on Seal and Sail rocks but it is unknown if there are still colonies there.

San Juan Islands

It is thought that all colonies of tufted puffins in the San Juan Islands region have been extirpated including Bare Island (historic counts of 100 birds), Colville Island (30), and 9 other colonies that used to have less than 10 birds each (Piatt and Kitaysky 2002). Speich and Wahl (1989) observed 60 breeding tufted puffins on Bare and Colville islands and historically approximately 14 other colony islands in the San Juan region, including Viti Rock.

Table 9.3 Known Washington's tufted puffin nesting colonies.

Conservation Zone	**Washington County**	**Island/Rock**	**Current or past nesting population**
1- Strait of Juan de Fuca	Jefferson	Protection Island	Current
1- Strait of Juan de Fuca	Clallam	Seal and Sail Rocks	Past
1-San Juan	San Juan	Bare Island	Past
1-San Juan	San Juan	Colville Island	Past
1-San Juan	Island	Smith Island	Current
1-San Juan	Skagit	Viti Island	Past
2-North Coast	Clallam	Tatoosh Island	Current
2-North Coast	Clallam	Jagged Island	Current
2-North Coast	Clallam	Carroll Island	Past
2-North Coast	Jefferson	Alexander Island	Current

Taken from data from Speich and Wahl (1989) and Piatt and Kitaysky (2002).

<u>Conservation Zone 2:</u> Washington's North and South Coast

Recent tufted puffin population trends for the northern coast of Washington/Tatoosh Island for 15 years is -16.9 percent population change annually (Table 9.3). Whole island counts declined similarly from highs of 200 – 300 birds in 1979 to highs of 14-30 birds 1998 through 2001. Speich and Wahl (1989) mention tufted puffins at 24 known colonies along the Washington's coast from the north coast/Tatoosh Island to the south coast/Point Grenville. The largest tufted puffin colony is on Jagged Island where 7,800 breeding birds are estimated but again trends show a drastic decrease in nesting colony numbers.

Tufted puffin pelagic-bird transects off the southern Washington coast, Westport, initiated in 1972 and conducted every year since (Wahl and Tweit 2000) showed variable but stable population numbers throughout 1970s and 1980s, but started a steady decline in 1989 to the order of magnitude lower counts in recent years. Trend for the past 15 years is -13.6 percent population change annually (Table 9.2).

Figure 9.2 Tufted puffins in Washington State.

Habitat Abundance

Marine

Tufted puffins spend a majority of the year inhabiting deep, oceanic waters of the Central North Pacific. This vast area consists of Subarctic, Transitional, and Subtropical Domains characterized by fairly uniform water properties from west (Japan) to east (California), but with large property gradients from north (Alaska) to south (Hawaii) (Gould and Piatt 1993).

Terrestrial

Tufted puffins nest and breed on land including on rocks, on islands, and off coastal regions. Nesting islets and rocks can be <1 hectare and offshore islands can range >1 – 10 kilometer squared (Piatt and Kitaysky 2002). Their nesting burrows are typically two to six feet long, and four to six inches in diameter. In highly populated colonies, the burrows of two or three of the animals sometimes run together. (Gaston and Jones 1998; Paul et al. 1994). Along the North American coast, several colonies are located in and protected under the FWS National Wildlife

Refuges. In Washington, this includes the San Juan Island and Protection Island National Wildlife Refuges, and along the northern Washington coast, the National Wildlife Refuges of Flattery Rocks, Quillayute Needles, and Copalis.

Threats

Tufted puffins remain subject to a variety of threats. The species' exact cause of decline is unknown but includes threats in both marine and terrestrial environments.

Habitat loss

There is some nesting habitat loss for tufted puffins, but many colonies are protected within refuges. Tufted puffin habitat loss is in the marine environment as well. The reduction of marine plant habitat, for example phytoplankton/eelgrass, a major source of food for small schooling fish that are in turn preyed upon by tufted puffins and all seabirds alike, produce a cascading effect at higher tropic levels.

Threats in the Marine Environment

Threats to tufted puffins in the marine environment range from commercial and recreational fisheries interactions, to pollutants and contaminants, to global climate change and sea-surface temperature increase.

Fisheries Interaction – Gillnets and Longlines; Prey Availability

Seabird by-catch in gillnets is widespread in the North Pacific. From the 1950s to the 1990s, tens of thousands of seabirds were killed in offshore salmon and squid drift-net fisheries (DeGange and Day 1991; DeGange et al. 1993). During the 1980s alone, squid drift-net fisheries killed an estimated 123,000[4] seabirds, annually. Seabirds caught in gillnets declined in the 1990s (Johnson et al. 1993) due to an almost eliminated high-seas drift net fisheries, however, drift-net fisheries for salmon continued in the Russian economic zone (Bering Sea, Kurils, Sea of Okhotsk) killing 15,000 to 30,000 tufted puffins annually during this same time (Artyukhin and Burkanov 2000). Coastal gill-net fisheries continue to catch birds in Alaska, Russia, and Japan, but the magnitude of by-catch is unknown (DeGange et al. 1993).

Reduction of seabird prey abundance by fisheries and the effects on seabird populations are difficult to assess. Even where it is documented that seabirds are affected by a reduction in prey, it is difficult to prove a causal relationship to fishery harvest.

[4] Annually an estimated 123,000 plus or -124,000; 95% CI (DeGange et al. 1993).

Pollutants and Contaminants

Organochlorine and heavy-metal contamination of eggs and tissue are widespread in tufted puffins, although generally in low concentrations with no known toxic effects (Elliot and Nobel 1993; Ohlendorf et al. 1982; Ohlendorf 1993; Tanaka 1989).

Plastics are another oceanic pollutant. Wehle (1980) showed that 26.3 percent of all puffin stomachs analyzed contained plastics. Day (1980) found plastic in the stomachs of 15 of 37 species of Alaskan marine birds, including tufted puffin, and found that the incidence of plastic in birds collected in the Aleutian Islands was greater than in birds collected in the Gulf of Alaska or the Bering or Chukchi Seas. Therefore, geography plays a role in the distribution of the plastics by currents, wind, etc. The source of plastic ingestion by puffins and other seabirds is probably due to the birds mistaking plastic for natural prey (Day 1980). Robards et al. (1995) found plastic particles frequently in seabird gizzards, with 20 percent of 837 tufted puffins examined in subarctic Alaska (between 1969 and 1990) and 88 percent of 8 puffins from Central North Pacific (between 1990 -1991) in which he broke the plastics into 2 main types: industrial pellets (40 percent) and "user plastics" of containers and toys (60 percent). Plastics could obstruct the passage of food or affect physiology of seabirds (Piatt and Kitaysky 2002) and the higher incident of plastics observed among subadults in the Wehle (1980) study leads one to speculate that subadults may be less able to distinguish plastic from natural prey.

Tufted puffins are vulnerable to oil pollution. Frequent oil spills are found related to historic tufted puffin population declines in California (Ainley and Boekelheide 1990). About 570 tufted puffins were retrieved in the aftermath of Exxon Valdez spill in the Prince William Sound, Alaska in March 1989 (Piatt et al. 1990) and the number killed may have been as high as 13,000 (Piatt and Kitaysky 2002), although many apparently died of starvation after the spill (Piatt et al. 1990). As much as 9 percent of Washington tufted puffins may have been killed in 1991 Tenyo Maru oil spill.

Oil Pollution in Washington State

As per the January 7, 2000, Federal Register (65 FR 1165-1166), FWS, on behalf of the Department of the Interior, the National Oceanic and Atmospheric Administration, the State of Washington, and the Makah Tribe, announced the release for public review of a Revised Draft Restoration Plan and Environmental Assessment for the Tenyo Maru Oil Spill. It described that on July 22, 1991, a Japanese fishing vessel (Tenyo Maru) and a Chinese freighter (Tuo Hai) collided about 20 miles northwest of Neah Bay, Washington, spilling at least 100,000 gallons of oil. Beaches were fouled with oil from Vancouver Island, British Columbia to northern Oregon. While impacts were scattered along the entire Washington State shoreline and the northern beaches of Oregon, the heaviest oiling occurred along the Makah Indian Reservation and the Olympic National Park shoreline. Seabirds were injured by the spill and the Trustees documented that many seabirds, including tufted puffins, were killed. Oil was observed from Cape Alava north to Tatoosh Island and from Tatoosh Island east to Waadah Island. On February 10, 1999, the Trustees published a Notice of Availability for a draft Plan/Assessment and received numerous comments on this draft Plan/Assessment. In response to those comments, the Trustees made several changes to the Plan/Assessment; one of these

changes included an option to consider a project involving restoration of tufted puffins and elimination of the Seabird By-Catch Reduction in Coastal Net Fisheries Project.

Global Climate Change and Sea-Surface Temperatures

Sea-surface temperatures are associated with inter-annual and decadal variability as well as with long-term climate changes indicative of global warming. Such oscillations could precipitate changes in a variety of oceanic processes to affect marine species worldwide. As global temperatures continue to rise, it will be critically important to be able to predict the effects of such changes on species' abundance, distribution, and ecological relationships so as to identify vulnerable populations (Gjerdrum et al. 2003).

A tufted puffin reproduction study based on 16 years of reproductive data off the coast of British Columbia collected between 1975 and 2002 showed that the extreme variation in reproductive performance exhibited by tufted puffins was related to changes in sea-surface temperatures both within and among seasons. Warm sea-surface temperatures corresponded with a drastic decrease in growth rates and fledging success of puffin nestlings; tufted puffins partially compensate for within-season changes associated with sea-surface temperatures by adjusting their breeding phenology (Gjerdrum et al. 2003). Therefore tufted puffins are highly vulnerable to the effects of climate change and may serve as a valuable indicator of biological change in the North Pacific. Further and prolonged increases in ocean temperature could render some breeding sites unsuitable for tufted puffins.

Threats in the Terrestrial Environment

Threats to tufted puffins and their colonies in the terrestrial environment are mainly human induced. These activities include disturbance and the introduction of non-native predators.

Disturbance

It is thought that investigator disturbance during tufted puffin incubation or hatching may cause desertion (Amaral 1977; Pierce and Simons 1986; Wehle 1980). One study found that frequent visitation and activities reduced tufted puffin fledging success from an undisturbed rate of 94 to 18 percent in heavily disturbed area (Pierce and Simons 1986).

Introduced/Non-native species

Introduced predators, specifically mammalian predators have decimated or eliminated seabird populations on many islands, and the tufted puffin is strongly affected due to their nesting in burrows (Bailey 1993; Bailey and Kaiser 1993). The main mammalian predators, once absent from most islands in the Northeast Pacific include the arctic fox (*Alopex lagopus*) and red fox (*Vulpes vulpes*), Norway rats (*Rattus norvegicus*), and ground squirrels (*Spermophilus undulates*). These species were thought to be introduced to Alaska during the 1800s and early 1900s. In Oregon, red foxes invaded several offshore rocks within the Oregon Islands National Wildlife Refuge which were accessible at low tides. Foxes destroyed all seabird eggs and chicks on the islands in 2002, resulting in total colony failure for many seabirds, including the tufted

puffin (FWS 2005c).

Other Threats

Disease

The colonial behavior of seabirds makes them highly susceptible to infectious (viruses, bacteria, parasites) and non-infectious disease (toxins, toxicants, metabolic) (FWS 2005c).

Conservation Needs

Long-term conservation needs include increasing productivity (abundance, the ratio of juveniles to adults, and nest success) and population size; protecting the quality 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.

Conservation Strategy

The FWS Seabird Conservation Plan for the Pacific Region lists the priorities for seabird conservation as the following strategies: 1) Habitat Management; 2) Threat Management; 3) Inventory and Monitoring; 4) Research; 5) Outreach and Education; and 6) Planning and Coordination. The first three strategies related to tufted puffins are discussed below.

Habitat Management

Most tufted puffin colonies are protected in the coterminous United States by the FWS's National Wildlife Refuge System. In Washington, 83 reefs, rocks, and islands in the San Juan Islands have been set aside as San Juan Islands National Wildlife Refuge. These islands (totaling almost 450 acres) have also been designated by Congress as a wilderness area where seabirds, eagles, and marine mammals will have an undisturbed place to live and raise their young. The FWS's efforts to secure protection for all important breeding and roosting sites is an ongoing activity and the National Wildlife Refuge staffs continue to work with communities, industry, military, and state agencies to educate on the effects of disturbance to nesting seabirds and to enforce regulations that protect them. Many National Wildlife Refuges have a buffer zone around seabird colonies. Buoys are placed around some of the National Wildlife Refuges each spring to restrict boat traffic within 500 feet of the nesting colony and regulate human entry to minimize disturbance to the nesting birds.

Habitat management should not just include the terrestrial environment but also the marine environment. Protection of marine prey species and their habitat and the management of marine threats are key strategies to accomplish tufted puffin productivity. Marine management options

may be the same as terrestrial management with such strategies as buffers placed on eelgrass beds etc.

Threat Management

As stated in the FWS Seabird Conservation Plan Pacific Region, seabirds are extremely vulnerable to factors that reduce survival because of their low fecundity. Small decreases in survival can result in population declines and hamper recovery. It is important that threats be identified early, seabird populations be monitored appropriately, and negative impacts be detected quickly, so that actions can be taken.

Fisheries Interaction – e.g. Gillnets and Longlines

Gillnets and longlines kill the greatest number of seabirds in the Pacific Region (FWS 2005c). By-catch in fishing gear is a localized management issue, infrequently addressed by local, State, or Federal fishery-management agencies by closure of fisheries or change in fishing practices (DeGange et al. 1993). Fishing regulations or small changes in fishing practices need to be addressed on a local and state level. Seabird by-catch was reduced by up to 75 percent in the Puget Sound sockeye salmon gillnet fisheries by regulating the use of visible mesh panels and eliminating dawn fishing (FWS 2005c).

Introduced/Non-Native Species

Introduction of non-native, invasive plant and animal species have resulted in disastrous consequences for seabird populations worldwide and they continue to pose one of the greatest threats to seabirds. One conservation strategy is the eradication of mammalian predators and vigilance campaigns to prevent their introduction, which benefits all seabirds and tufted puffins in particular (Bailey 1993; Byrd et al. *in litt.* 1991). Control and eradication of introduced plants has been implemented at a few seabird colony sites, and the same is true with introduced insects, but these projects are labor intensive and expensive, and much more needs to be done (FWS 2005c). Preventing introductions of non-native species is the best conservation strategy, such as by regulating access to islands as many pests reach islands through human transport. Introduction of non-native species, especially predators, is an emergency and should be treated as such with rapid response to minimize damage and restoration cost (FWS 2005c).

Pollutants and Contaminants

Major sources of contaminants including industrial and mining discharge, agricultural runoff (pesticides, sediment, and nutrients), urban runoff and sewage outfalls, and military base contaminants are widespread within the Region. The greatest potential exposure hazard to seabirds are persistent organic pollutants (e.g. pesticides, dioxins, PCBs, and poly-aromatic hydrocarbons), metals (mercury, lead, arsenic, cadmium, chromium, and copper), and trace minerals. Regulation and the monitoring of chemicals are needed. The lack of dose-response data for seabirds is a significant problem in the monitoring and evaluation of contaminant problems (FWS 2005c) that needs to be addressed.
Plastics are concentrated by ocean currents along the same fronts and convergences that

concentrate prey items. A management plan to deal with plastics in water and along the shores needs to be addressed such as is implemented on roadways through volunteer litter patrols.

The FWS Seabird Conservation Plan Pacific Region includes fuel discharge as one of their four major sources of contaminants. For spills such as oil, specialized response techniques need to be developed for detecting and assessing impacts to seabirds in this ecosystem. In California and Washington there is a well-developed oil spill response and seabird injury assessment programs (FWS 2005c).

Global Climate Change/ Sea-Surface Temperature

Sea-surface temperatures have risen 1 degree Celsius over the past century and are expected to increase by up to another 3 degrees Celsius over the next 100 years if current trends continue (NWF 2007). Monitoring and planning for increases in sea-surface temperature would benefit seabird conservation including the tufted puffin. This monitoring and planning should take into account that the increase in sea-surface temperature may reduce the availability of phytoplankton, a major source of food for small schooling fish that are in turn preyed upon by a variety of seabirds, potentially producing a cascade of negative effects at higher trophic levels.

Inventory and Monitoring

The FWS Seabird Conservation Plan for the Pacific Region describes population inventories and population monitoring as a management strategy. The goal of an inventory is to identify all colonies within a given area and enumerate the total breeding population at each colony. Seabird inventories provide invaluable information on distribution and abundance at a large-scale; however, large scale inventories are insufficient to accurately detect or monitor population trends. Given the long life span, low fecundity, and high adult survival typical of seabirds, very small annual changes in breeding populations may signal profound long-term changes in population growth rates. Rigorous collection of population data is needed to accurately detect these trends but is currently conducted at very few sites. One site that does long-term population monitoring is the Farallon National Wildlife Refuge off the west coast of San Francisco, California. Since 1971 eleven seabird species have been monitored at the Farallon Islands including the tufted puffin. This monitoring includes annual estimates of breeding population size and reproductive success, detailed protocols, and then the implementation of the protocols into the monitoring program.

Summary

Tufted puffins spend a majority of the year over the Pacific Ocean, where they winter over deep, oceanic water. Puffins nest along coastlines and offshore islands in California, Oregon, Washington, British Columbia, Alaska (Gulf of Alaska and the Aleutian Islands), the Bering and Chukchi Seas, and Japan to the shores of northeastern Asia.

The total tufted puffin breeding population has been estimated at fewer than 3 million breeders. Approximately 82 percent of the tufted puffins breed in North America and only 1 percent breed

in the Pacific Region. Based on data from numerous published and unpublished sources, declines of 3 percent - 21 percent per annum were estimated in California, Oregon, and Washington over the past 15 years.

Threats continue to contribute to tufted puffin population declines. These include habitat loss, prey habitat loss, prey availability, fisheries interaction including gillnets and longlines, pollutants and contaminants including oil spills, global climate and sea-surface temperature change, disturbance, introduced/non-native species, and disease.

The tufted puffin is a Federal species of concern, and the life history characteristics and threats to the puffin make this species highly susceptible to local extirpations, specifically in Washington State. Accordingly, the FWS concludes the current environmental conditions for the tufted puffin 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 tufted puffins are nesting at or near the carrying capacity in the remaining nesting habitat, activities which degrade the existing conditions of occupied nesting habitat or reduce adult survivorship and/or nest success of tufted puffins 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 exacerbate the current tufted puffin population decline throughout the coterminous United States.

10.0 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.

The proposed action directly and indirectly affects major portions of the Puget Sound basin including the San Juan Islands and portions of the Strait of Juan de Fuca. To adequately describe the current baseline, it is necessary to discuss the past and current conditions as well as the on-going activities on a Puget Sound basin-wide basis. The Puget Sound Action Team recently completed a comprehensive report of the conditions of Puget Sound referred to as the “2007 Puget Sound Update”. Ongoing monitoring and research in the Puget Sound basin via the PSAMP were the basis for this report. The report also includes research findings from a variety of additional monitoring and research efforts conducted by local governments, research institutions, Tribes, State and Federal agencies, and citizen monitoring groups. The scope of the report is the marine and freshwater ecosystems of the Puget Sound Region focusing on water quality, toxic contamination, nearshore habitat, and marine species. The following excerpts, unless otherwise cited, have been taken from the 2007 Puget Sound Update, and are being used to establish the environmental baseline for this consultation.

The Geoduck HCP plan area occurs within the submerged lands of Puget Sound, the Strait of Juan de Fuca, and areas north to the Canadian border (Figure 2.1 which also shows

management regions and Figure 2.2). Within this broad area, commercial geoduck harvest occurs subtidally in areas that have been surveyed between depth contours of –18 and –70 feet (corrected to mean lower low water [MLLW]) and found to contain geoducks at sufficient densities to sustain a harvest. Following environmental and health review, specific areas (tracts) are identified as appropriate for commercial harvest (WDNR 2008).

Physical Environment and Habitat

Puget Sound is a large inland fjord carved by glaciers, fed by over 10,000 rivers and streams that flow into the Sound from the encircling Cascade and Olympic mountain ranges. The Sound is deep, with an average depth of 450 feet (137 meters), and the maximum depth of 930 feet (283 meters) occurring immediately north of Seattle. Ten large rivers—the Nooksack, Skagit, Snohomish, Stillaguamish, Cedar/Lake Washington Canal, Green/Duwamish, Puyallup, Nisqually, Skokomish, and Elwha—flow into Puget Sound and contribute nearly 85 percent of the fresh water that enters the Sound. The unique geology and large dynamic river systems help shape the shoreline, which consists of 2,500 miles (4,023 km) of beaches, bluffs, bays, estuaries, mudflats, salt marshes, and wetlands.

The Strait of Juan de Fuca connects Puget Sound with the Strait of Georgia to the north and Pacific Ocean to the west. Within this region are numerous basins, sub-basins, passages, and bays. To develop a common basis for monitoring and reporting, PSAMP has delineated six main basins in Puget Sound. From the north, the basins are: San Juan Archipelago, the Strait of Juan de Fuca, North Puget Sound (Whidbey Basin and Admiralty Inlet), Central Puget Sound, Hood Canal, and South Puget Sound. The boundaries of many basins coincide with sills; for others the demarcation is arbitrary.

Key findings of the 2007 Puget Sound Update include the following:

- Average global sea surface temperature has increased by 1.7 degrees F (0.9°C) since 1921.

- Hood Canal, Budd Inlet, Penn Cove, Saratoga Passage, and Possession Sound are locations of highest concern, based on Ecology's index of water quality for Puget Sound. Eleven other areas are of high concern.

- Overall DO concentrations in Puget Sound appear to be continuing a downward trend. Very low DO was observed at 14 stations, seven of which had higher DO concentrations in the period from 1998 to 2000. Another seven stations with previously high DO concentrations experienced low DO during 2001-2005.

- Hood Canal DO levels measured during 2004 were at the historical low point for any recorded observations. Comparing oxygen data from 1930 -1960s with data from 1990 - 2006, shows that in recent years, the area of low dissolved oxygen is getting larger and spreading northwards. Periods of hypoxia are persisting longer through the year.

- Tidal wetland losses were documented throughout Puget Sound and at present, approximately 82 percent of the historic extents of tidal wetlands in the region have been lost to development and other land uses.

Biological Resources

Puget Sound's biological resources include all living organisms that inhabit the marine waters and shorelines. These resources are plankton, invertebrates, fish, birds, mammals, and aquatic vegetation, including species that are either residential or migratory. Many biological stressors are affecting or have affected biota in Puget Sound in ways that we are only beginning to understand. These include climate change, toxic contamination, eutrophication (low oxygen due to excess nutrients), and nearshore habitat alteration.

Significant changes in the biological communities of Puget Sound have occurred in the past 30 years, including declines in population numbers of forage fish, salmonids, bottomfish, marine birds, and orcas. These changes have not gone unnoticed, resulting in restricted and closed fisheries, petitions to list species under state programs and the Act, and development of recovery and management plans for several species. Coordinated efforts by PSAMP and other monitoring and research programs are underway to evaluate the declines, identify the stressors affecting the populations, and develop actions and solutions to stem the declines and begin rebuilding populations of species at risk.

A recent study (Gaydos 2004) identified 47 marine species of concern in the Puget Sound—three invertebrates, 23 fishes, one reptile, 11 birds, and nine mammals. In status reviews conducted for the 14 species of fish and wildlife listed as threatened or endangered by Washington State or the Federal government; contaminants, habitat loss, and over-harvest were the most frequent causes cited for species declines.

Key findings of the 2007 Puget Sound Update include the following:

- Nearly 60 percent of groundfish stocks in Puget Sound are in good condition. Those in decline include middle-trophic level predators such as rockfishes, spiny dogfish, Pacific cod, and hake.

- Spawning potential for copper and quillback rockfish dropped by nearly 75 percent between 1970 and 1999, and more recent information confirms a continued decline. Although the overall number of groundfish has not changed significantly in the last few decades, many popular harvest species have sharply declined while others species of groundfish have increased.

- The total Pacific herring spawning biomass from Puget Sound's 19 stocks decreased between 2002 and 2005, and increased in 2006. The Cherry Point stock in North Puget Sound has experienced a dramatic decrease since a high of 12,000 tons in 1976, a low of only 800 tons in 2000, followed by a gradual increase to 2,200 tons in 2006.

- Southern resident orcas were added to the Federal endangered species list in 2005. The

population currently consists of 86 whales, down from a peak of 98 in 1975.

- Surf scoters, white-winged scoters, and black scoters have collectively declined by approximately 57 percent between 1978 and 1999. This decline has continued from 1999 through 2005 in nearly all of the subregions of Puget Sound. The decrease in scoters represents the largest decline in biomass of marine birds over the last 25 years in Puget Sound.

- Loons and grebes that over-winter in Puget Sound have declined by nearly 75 percent over the past 10 years. It is unknown whether this reflects declines in the overall populations or whether birds are over-wintering outside of Puget Sound.

- Native eelgrass has declined in Hood Canal for four consecutive years since 2001. The San Juan Archipelago has experienced declines in small embayments. In eleven embayments approximately 83 acres of eelgrass were lost between 1995 and 2004.

- Sea lions have become more abundant in Washington waters. The California sea lion populations have increased by about 5 percent annually, with a current population of 4,000 - 5,000 animals. Steller sea lions are also increasing in population, by about 10 percent annually. Surveys conducted in 2005 of Steller sea lions during peak abundances in fall and winter recorded 1,000 - 1,500 sea lions along Washington's outer coast. This species also regularly inhabits North Puget Sound.

- Harbor seals have been steadily increasing in population since the early 1970s, with current populations consisting of 16,000 seals along the outer Washington coast and 14,000 in the inland waters of Puget Sound.

- The pinto abalone, a once fairly abundant native species in Hood Canal, north Puget Sound and the San Juan Islands, appears to be critically depressed and in such low abundance that this species may be unable to naturally reproduce. In the San Juan Archipelago, between 1992 and 2005, abalone has declined from 351 animals per site to 103 animals per site at 10 long-term monitoring stations.

- Restoration of the Olympia oyster, a native shellfish species, has been successful in expanding the oyster's historic range in Puget Sound.

- Results from monitoring marine reserves in Puget Sound have shown that, within a decade, lingcod have become abundant and, as top predators, are keystone species that help characterize the trophic and ecological structures of rocky habitats.

- Fifty-two non-native species have been documented in Puget Sound, a large percentage of these were probably introduced via ship ballast. The European green crab, Chinese mitten crab, and zebra mussel are non-native species that could arrive at anytime and threaten Puget Sound's biological resources.

Toxic Contamination

In the past 150 years, people have released a wide variety of chemicals into Puget Sound and its watersheds, many of which are toxic to humans, animals, and plants. While contamination by a number of toxics, such as lead, PCBs, and dioxins, has been reduced by use restrictions, other chemicals continue to be used and many enter into Puget Sound through stormwater runoff, wastewater discharges, and nonpoint sources, adding to a legacy of contamination.

Puget Sound is unique among North American estuaries, because of its geologically young, deep, narrow, fjord-like structure. Several shallow sills restrict the entry of deep oceanic water into Puget Sound, which reduces flushing of these inland marine and estuarine waters compared to the other urbanized estuaries of North America. Thus, toxic chemicals that enter Puget Sound remain longer within the system, and the trapping of toxics means that biota are subject to increased exposure. This hydrologic isolation also puts Puget Sound at higher risk from nutrients and pathogens that may enter the system.

The combination of hydrologic isolation with the persistent (resisting degradation) and bioaccumulative (increasing within organisms over time) nature of many chemical contaminants creates additional risk for the Puget Sound ecosystem. For example, Chinook salmon that remain as residents in Puget Sound (both as a result of natural tendencies and hatchery practices), rather than migrate to the ocean, are several times more contaminated than other Chinook populations along the West Coast. Another disturbing indication of this is found in Pacific herring, one of Puget Sound's keystone forage fish species. These fish live almost all of their lives in pelagic waters, so one might suspect they would be among the least contaminated of fish species. However, PSAMP scientists have shown high body burdens of PCBs in this species from the central and Southern basins of Puget Sound—comparable to herring from northern Europe's severely contaminated Baltic Sea.

The toxic contaminants that harm or threaten the health of the Puget Sound ecosystem include chemicals designed and synthesized to meet industrial needs, agricultural products such as pesticides, byproducts of manufacturing or the combustion of fuel, fossil fuels, and naturally occurring toxic elements that may become unusually highly concentrated in the environment because of human uses or other activities. Release of these chemicals to the environment can occur through designed and controlled human actions (e.g., application of pesticides or the discharge of wastes through outfall pipes, smokestacks, and exhaust pipes) or as unintended consequences of human activities (e.g., oil and chemical spills, leaching from landfills, and runoff of chemicals from the deterioration or wear of roofs, pavement, and tires).

Key findings of the 2007 Puget Sound Update include the following:

- Approximately one percent of Puget Sound sediments are highly degraded, 31 percent are of intermediate quality, and 68 percent are of high quality. The degraded sediments (as measured by toxicity, chemistry, and benthic infauna) are mainly associated with urban embayments that are often located near river deltas and other highly productive nearshore habitat of importance to Puget Sound species.

- Chinook salmon from Puget Sound have nearly three to five times the PCB levels of Chinook from Alaska, British Columbia, and Oregon.

- Flame retardants, or polybrominated diphenyl ethers (PBDEs) occurred in 17 percent of sediment sites sampled in Hood Canal in 2004 and were detected in 16 percent of samples from 10 Puget Soundwide sediment sampling sites in 2005.

- PBDEs are now second to PCBs in order of importance in the Puget Sound food web. PBDEs in English sole from urban areas are almost 10 times higher than those levels measured in sole from the Georgia Basin. Pacific herring from Puget Sound have nearly three times the levels of PBDEs in Georgia Basin herring. Harbor seals from Puget Sound have over twice the PBDEs found in seals near Vancouver, BC. Scientists estimate that PBDE levels are doubling every four years in marine mammals, including harbor seals and orcas, and will surpass PCB levels in these species by 2020.

- In Puget Sound sediments, polycyclic aromatic hydrocarbons (PAHs) like creosote have not changed significantly over the past decade, except in Bellingham Bay, Port Gardner, and Anderson Island, where levels have increased. Point Pully (in central Puget Sound) had a significant decrease in PAHs during this same period.

- In Dungeness crab, PAH exposure was six times higher in urban areas than in non-urban areas. English sole had three to four times the PAH exposure in urban areas, compared to non-urban areas.

- English sole from Elliott Bay and the Foss Waterway had four to six times the risk of developing liver lesions, (typically associated with PAH exposure), compared to sole from Hood Canal or the Strait of Georgia.

- Six endocrine-disrupting compounds (bisphenol A, estradiol, ethynylestradiol, and three phthalates) were detected in more than 20 percent of surface-water samples collected in King County's lakes, rivers, streams, and stormwater discharges.

- Male English sole from several Puget Sound locations (including 30 percent of males from Elliott Bay) are producing an egg protein (vitellogenin) normally found only in female fish. This finding suggests that these fish have been exposed to endocrine disrupting compounds.

- Pre-spawn mortality occurred in 25 to 90 percent of female coho salmon returning to urban streams in the Puget Sound region between 2002 and 2005, suggesting that contaminants from stormwater are posing a threat to the spawning success of salmon in urban streams.

Nutrients and Pathogens

Water quality is a primary factor affecting the health of marine and freshwater species in the Puget Sound region. As Washington's population grows and urbanization of the Puget Sound area continues, freshwater and marine ecosystems are under rising pressure from human activities that increase nutrient and pathogen pollution. Inputs of nutrients and pathogens affect ecosystem functions, the health and habitat of aquatic species, including economically important species (such as salmon and shellfish), and human health.

Nutrients consist of a variety of natural and synthetic substances that stimulate plant growth and enrich aquatic ecosystems. As a general rule, phosphorus tends to be the limiting nutrient in freshwater systems, and nitrogen tends to be the limiting nutrient in marine systems. This means that increased loadings of these nutrients can have significant effects on the character and condition of these respective systems.

Human activities have had a profound effect on the cycling of nutrients worldwide and nutrient pollution in the Puget Sound basin. Nutrient availability in Puget Sound involves inputs from natural and human sources, such as upwelling and inflow of oceanic waters, flows from rivers and streams, stormwater runoff carrying fertilizers and other materials, discharges from sewage treatment plants, atmospheric deposition, and numerous other sources. It also involves uptake by phytoplankton and other aquatic vegetation and export to oceanic waters.

Monitoring of nutrients is critical for assessing and understanding both short- and long-term changes in water quality and their effects on the Puget Sound marine ecosystem. Increased nutrient loading can dramatically change the structure and function of freshwater and marine ecosystems by altering biogeochemical cycles and producing cascading effects throughout the ecosystem and food web, such as prolonged algae blooms, depressed oxygen levels, fish kills and losses of aquatic vegetation. Eutrophication, as these nutrient-driven changes are known, is one the most important challenges facing Puget Sound and coastal ecosystems worldwide.

Pathogen pollution is an equally significant water quality problem in the Puget Sound basin. Pathogens are disease-causing microorganisms that include a variety of protozoa, bacteria, and viruses. Some pathogens occur naturally in the marine environment (e.g., *Vibrio parahaemolyticus*). Most, however, are carried by host organisms and are associated with human and animals feces from such sources as onsite sewage systems and municipal sewage treatment plants, stormwater runoff, and boat waste. Pathogen pollution causes a range of environmental, human health, and economic impacts that include the contamination of shellfish beds, recreational waters and beaches, drinking water supplies, and other water-related resources.

Pathogens also disrupt ecosystem functions and affect populations of freshwater, marine and

terrestrial species. Increases in development around Puget Sound have prompted many investigations into the sources, loadings, pathways, and effects of nutrient and pathogen pollution. This information is needed to better understand the nature and scope of the problems and to inform management plans and efforts to prevent and control the pollution sources.

Key findings of the 2007 Puget Sound Update include the following:

Fresh Water

- In Ecology's 2004 Water Quality Assessment, 58 freshwater sites were identified with DO problems in Puget Sound because of excessive nutrients (phosphorus and nitrogen) in the streams. Nutrients sources include drainage from agricultural, forestry, and residential activities and other sources.

- Twenty-five of 38 freshwater stations were scored "Good" according to the total nitrogen Water Quality Index (WQI). Ten stations scored "Fair." Three stations (in Hood Canal and on the Deschutes River near Olympia) scored "Poor."

- In 2005, freshwater stations were nearly equally divided between "Good" and "Fair" for phosphorus and were stable in water years 2000 through 2005.

- The WQI for fecal coliform rated "Good" at 28 of 38 freshwater streams for fecal pollution. The remainders were "Fair." Fecal conditions appear to be stable since 2000.

Marine Waters

- Hood Canal, Budd Inlet, Penn Cove, Saratoga Passage, and Possession Sound are locations of highest concern, based on Ecology's index of water quality for Puget Sound.

- Stations in Hood Canal, Penn Cove, Possession Sound, and Saratoga Passage had very high sensitivity to eutrophication, suggesting that these locations are at greatest risk for further declines in water quality due to human additions of nutrients.

- The most recent Water Quality Assessment lists 76 water bodies in Puget Sound with fecal coliform problems. However, fecal coliform data collected at marine ambient stations suggest a general decline in fecal coliform contamination from 2001 through 2005. The highest levels of fecal contamination occurred in Budd Inlet, Commencement Bay, Elliott Bay, and near West Point (north of Elliott Bay), Possession Sound, and Port Angeles harbor.

- Department of Health determined that 31 of 98 shellfish growing areas in Puget Sound experienced significant fecal pollution in 2005. Those with the greatest impact were Drayton Harbor, Dungeness Bay, and Henderson Inlet. Samish Bay and Burley Lagoon show no evidence of change in fecal pollution since 2002.

- Between 1995 and 2005, over 12,500 acres of shellfish growing areas were upgraded and 5,000 acres were downgraded, for a net increase of 8,500 acres. As a result of Kitsap County's Pollution Identification and Correction Program, parts of four shellfish harvest areas have been cleaned up and reopened for harvest; Burley Lagoon, Cedar Cove (part of Port Gamble), Illahee State Park, and Dyes Inlet.

- Twenty percent of 428 recreational beaches in 12 Puget Sound counties are threatened by fecal pollution. Five percent of these beaches are closed because of biotoxins. Within King County, trends at 21 recreational beaches indicate that fecal pollution has declined since 1997. Ecology's Beach Environmental Assessment, Communication and Health Program indicates that central Sound beaches typically have the highest measured bacterial pollution, most notably in Dyes and Sinclair Inlets.

- Eighteen of 29 paralytic shellfish poisoning (PSP) sampling sites (62 percent) had at least some PSP impact in 2005. Burley Lagoon ranked highest in PSP impact in 2005. The year 2003 appeared to be lowest in PSP activity throughout Puget Sound.

- In 2003, a short-lived *Pseudo-nitzschia* (pennate diatom) bloom occurred at Fort Flagler near Port Townsend. Mussels from the sentinel monitoring cage contained domoic acid slightly above the U.S. Food and Drug Administration's action level, and Department of Health closed the area to shellfish harvest. In October 2005, *Pseudo-nitzschia* blooms occurred at four places in north Puget Sound (Sequim Bay, Port Townsend, Holmes Harbor, and Penn Cove). Several shellfish species were affected. All four areas were closed to shellfish harvest.

Summary

The current baseline status for the Puget Sound basin is complex and dynamic. It is impossible to analyze the environmental baseline as a moment in time because past development and its associated effects are ongoing and will continue to impact Puget Sound natural resources in the future. Throughout Puget Sound, the threat of habitat loss increases as growth and associated urbanization, agriculture, and resource extraction convert the landscapes and seascapes from native flora and fauna to a human-altered one. As a result many native habitats have been dramatically reduced which, in turn, may have significant effects on the quantity and quality of habitats that native species depend upon.

Increasing development and sprawl in the Puget Sound, triggered by an increasing population, have fragmented and destroyed habitats, and will continue to contribute to the decline of many species and their habitats. The development and degradation of aquatic lands and the associated loss of fish and wildlife habitat is anticipated to continue, although certain plans, guidance, regulation, and marine reserves have been created to help reduce the impacts. Habitat loss and habitat degradation are expected to continue as the need for developed lands continues. One of the major threats to the Puget Sound landscape is the change from native forest cover to urban development, mostly driven by population growth. It is estimated that, in the next 20 years, the population in the Puget Sound basin will reach over 5 million people.

Lingering effects of past pollution and ongoing delivery of pollutants affect species and habitats, and the effects are expected to continue. Certain previously-banned chemicals continue to be found at elevated levels in many top predators such as orcas. Poor air and water quality, as well as hazardous wastes and oil spills have diminished the quality and usability of fish and wildlife habitats. Potential impacts include displacement and loss of individuals of some species, as well as decreased habitat quality. Recovery of fully-functioning habitat conditions in many areas, if possible, will take much time and effort, and new problem areas will certainly be detected in the near-term future.

To counter these impacts, certain rules and guidance (e.g., Shoreline Management Act) have been enacted and adopted by some jurisdictions. More recently, Washington State Governor Gregoire launched the Puget Sound Partnership (Partnership) to address these issues. In May 2007, the state legislature created a new agency to oversee the restoration of the environmental health of Puget Sound by 2020. The agency consists of a Leadership Council, an Executive Director, an Ecosystem Coordination Board, and a Puget Sound Science Panel. Three Federal agencies are represented on the Partnership's Ecosystem Coordination Board and four Federal scientists are on the Science Panel.

In July 2007, the Partnership was formed (ESSB 5372) with a mandate to create a healthy Puget Sound ecosystem by 2020 fulfilling 6 specific goals:

- Fresh and marine waters and sediments of a sufficient quality so that the waters in the region are safe for drinking, swimming, shellfish harvest and consumption, and other human uses and enjoyment, and are not harmful to the native marine mammals, fish, birds, and shellfish of the region.

- An ecosystem that is supported by ground water levels as well as rivers and stream flow levels sufficient to sustain people, fish, and wildlife, and the natural functions of the environment.

- A healthy Puget Sound where freshwater, estuary, nearshore, marine, and upland habitats are protected, restored and sustained.

- Healthy and sustaining populations of native species in Puget Sound, including a robust food web.

- A healthy human population supported by a healthy Puget Sound that is not threatened by changes in the ecosystem.

- A quality of human life that is sustained by a functioning Puget Sound ecosystem.

Currently an Action Agenda is being developed by the Partnership that will identify measurable parameters and target values that represent full achievement of each ecosystem goal associated with a healthy Puget Sound as well as, the necessary strategies and management activities to achieve those targets by 2020.

10.1 Bull trout and Bull Trout Critical Habitat

Bull Trout

The action area is within the Coastal-Puget Sound IRU and includes that portion of the MU that is encompassed by or connected to Puget Sound and that portion of the Olympic Peninsula MU encompassed by or connected to Hood Canal and the Strait of Juan de Fuca. Bull trout from 8 core areas that are connected to nearshore marine waters and 3 FMO areas outside of core areas are present in the action area. Core areas represent the closest approximation of a biologically functioning unit for bull trout (FWS 2004b). Core areas consist of habitat that could supply all the necessary elements for every life stage 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 units upon which to gauge recovery within the IRU. Bull trout from the following core areas are expected to be present in the action area: Puyallup, Stillaguamish, Snohomish/Skykomish, Lower Skagit, Nooksack, Skokomish, Dungeness and Elwha Rivers. Areas outside of core areas will also be affected: Puget Sound, Hood Canal, and Strait of Juan de Fuca. FMO habitat is also present in the action area. Unique to the Coastal-Puget Sound IRU, bull trout occur in marine nearshore waters and these areas support the complex migratory behaviors and requirements of the anadromous form of bull trout. As such, these areas are critical to the persistence of that life history form. Within the marine nearshore FMO areas, there is little or no documentation of bull trout in the marine waters of Puget Sound south of the Nisqually River, Hood Canal, Vashon Island, westside of Whidby Island, and the Kitsap Peninsula. It is considered unlikely or extremely rare for bull trout to be in those areas.

Hood Canal, Strait of Juan de Fuca and Puget Sound Marine Nearshore FMO

Anadromous adult and subadult bull trout utilize marine waters of the action area for FMO. In two recent telemetry studies documenting the extent of anadromy in bull trout within portions of the Coastal-Puget Sound IRU, approximately 55 percent of the fish tagged in freshwater emigrated to saltwater (Brenkman and Corbett 2005; Goetz et al. *in litt.* 2007). Results from these studies also demonstrate that anadromous bull trout inhabit a diverse range of estuarine, freshwater, and marine habitats.

Marine waters provide important habitat for anadromous bull trout for extended periods of time. Data for bull trout from Puget Sound indicate that the majority of anadromous bull trout tend to migrate into marine waters in the spring and return to rivers in the summer and fall period. Although much less frequent, tagged fish have been detected in Puget Sound nearshore marine waters during December and January, which indicates that some fish remain in marine waters during the winter (Goetz et al. 2005; USGS *in litt.* 2008). It is thought that warmer water temperatures in the summer may be an environmental cue that stimulates bull trout to return to freshwater. Other factors that may influence marine residency for bull trout include prey availability, predation risks, or spawn timing.

In general, anadromous bull trout use shallow nearshore, subtidal, and intertidal waters. In the study by Goetz and others (2005) the greatest bull trout densities were at depths greater than 2.0 to 2.5 meters (6.5 – 8.2 ft). Upon entering marine waters bull trout can make extensive, rapid migrations, usually in nearshore marine areas. During the majority of their marine residency,

anadromous bull trout have been found to occupy territories ranging in length from ~10m to >3 km (32 - 9,842 ft) within 100-400 m (328 – 1312 ft) of the shoreline (USGS *in litt.* 2008). Aquatic vegetation and substrate common to all or most bull trout areas includes eelgrass, green algae, sand, mud, and mixed fine substrates. These habitat features are also correlated with forage fish occurrence.

Some level of mixing or interaction within marine waters occurs among anadromous individuals from various core areas. Based on recent studies it is likely that bull trout from several core areas may be present within the action area simultaneously (Brenkman and Corbett 2005; Brenkman et al. 2007; Goetz et al. 2005; Goetz et al. *in litt.* 2007). It is expected that within the action area individual bull trout from the Puyallup, Stillaguamish, Snohomish/Skykomish, Lower Skagit, Nooksack, Skokomish. Dungeness and Elwha Rivers are likely to be present. Thus the status of each of these core areas is discussed below. Most of the information for the status of the core areas was developed in our draft recovery plan, listing packages, the science information gathered for the bull trout 5-year review, and other recent documents that depict the baselines such as county and watershed or subbasin plans.

Bull Trout Critical Habitat

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

Status of Coastal-Puget Sound Critical Habitat Units in the Action Area

Critical habitat areas are all located within marine nearshore habitat. These nearshore marine waters are important for subadult and adult bull trout migration, forage, and refugia. Improving water quality and the function of critical habitat in these areas will require restoration efforts and complex negotiations.

Critical habitat for bull trout within the actions area is designated in the inshore extent of marine nearshore areas (the MHHW line), including tidally influenced freshwater heads of estuaries. This refers to the average of all the higher high-water heights of the two daily tidal levels. The offshore extent of critical habitat for marine nearshore is based on the extent of the photic zone, which is the layer of water in which organisms are exposed to light. Critical habitat extends offshore to the depth of 33 ft (10 m) beyond the MLLW (average of all the lower low-water heights of the two daily tidal levels). This area between MHHW and -10 MLLW is considered the habitat used most consistently by bull trout in marine waters based on known use, forage fish availability, and ongoing migrations studies, and the area captures geological and ecological

processes important to maintaining these habitats. The area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Primary Constituent Elements for Marine Nearshore Waters

Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. The following PCEs apply to marine nearshore waters identified as critical habitat (70 FR 56212):

(i) Water temperatures that support bull trout use.

(vi) Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

(vii) An abundant food base including terrestrial organisms of riparian origin, aquatic macro invertebrates, and forage fish.

(viii) Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Critical Habitat Unit Status

Olympic Peninsula: Unit 27

Critical habitat has been designated in streams and rivers in all core areas within this unit and in the marine nearshore of the Pacific Ocean, Strait of Juan de Fuca, and Hood Canal. In the Elwha core area, critical habitat has also been designated in the Little River potential local population. Critical habitat has also been designated in the following FMO habitat outside of core areas: Bell, Cedar, Ennis, Goodman, Joe, Kalaloch, Morse, Mosquito, and Steamboat Creeks; Canyon, Chehalis, Copalis, Humptulips, Moclips, Satsop, and West Fork Satsop Rivers; and Grays Harbor, Hood Canal, Pacific Coast, and Strait of Juan de Fuca marine FMO habitats.

On the Olympic Peninsula, a significant portion of the major river basins, particularly the upper river portions where most bull trout spawning and rearing occurs, lie within the Olympic National Park. Spawning and rearing critical habitat has been designated in these areas within the Park. However, FMO critical habitat conditions are often degraded downstream of the park boundary (WSCC 2000, 2001). In the largely rural setting of the Olympic Peninsula, habitat effects are primarily related to past logging and associated roading and, to a lesser degree, dams and agricultural practices. Habitat conditions have improved to some extent over the past decade with more-protective forest practices and declining timber harvest on public lands. Although riverine migratory corridors are still functional, especially on the westside of the Olympic Peninsula, critical habitat conditions related to suitable temperatures, floodplain connectivity, substrate, timing and magnitude of flows, and habitat complexity related to large woody material have been degraded by historical land-management practices.

Critical habitat has also been designated in the marine nearshore of the Pacific Ocean, Strait of Juan de Fuca, and Hood Canal. Condition of the critical habitat in the Pacific Ocean has been impacted by roads and rural development. However, human population density is low, there is little industrial development, and the impacts to Pacific Ocean critical habitat are relatively minor. In Hood Canal extensive shoreline development has occurred, including diking and filling, shoreline armoring, and urbanization. Critically low DO levels have recently been observed in Hood Canal. Reasons for the low DO are unknown, but human activities and natural geography (e.g. excessive nutrient input, reduced freshwater input, low flushing rate) may be factors. Low dissolved oxygen zones have the potential to impede fish migration and forage fish health. In the eastern Strait of Juan de Fuca armoring occurs along 54 percent of the shoreline. Highway 101 is a significant constraint, and railroads follow much of the shoreline from Discovery Bay to Port Angeles. The damming of the Elwha River has reduced sediment loads to a portion of the central Straits and likely has accelerated erosion in some places. Shoreline development, urbanization, diking and filing, transportation related spills and discharges have impacted much of the marine nearshore and associated estuaries. A portion of PCEs 6, 7, and 8 within the designated critical habitat have been degraded, although the severity of degradation varies on a site specific basis.

Puget Sound: Unit 28

Critical habitat has been designated in streams and rivers throughout the Puget Sound Critical Habitat Unit. Critical habitat has also been designated outside of core areas in the marine nearshore waters of Puget Sound.

The urban rivers of Puget Sound have effects comparable to those on the Olympic Peninsula from past logging and logging roads in the upper reaches, but critical habitat has been further degraded in the lower floodplains. Intensive channelization to protect urban development and agricultural areas has resulted in permanent loss of floodplain functions in most of the lower rivers. The loss of riparian vegetation, increasing discharge of municipal and industrial wastewater and urban stormwater runoff, has resulted in degraded water quality. The Washington Department of Ecology has placed a large number of waterways throughout Puget Sound on the 303(d) list of impaired waters. In addition to affecting water quality through flow alterations, hydroelectric dams block migration and have isolated bull trout populations in several core areas while water-control structures in the floodplains have effectively eliminated most of the estuaries and wetlands that historically provided rearing and foraging areas. Throughout Puget Sound shoreline development, urbanization, diking and filling, susceptibility to spills and discharges are stressors that have degraded critical habitat. Railroads follow portions of the shoreline and much of the shoreline is armored. Concentrations of commercial and recreational overwater structures such as ramps, piers and docks can be found in Tacoma and Commencement Bay, the Lower Duwamish River and Elliot Bay. *Spartina* colonies are a concern in the Padilla/Samish Bay sub-basin, as they continue to try and take hold in the area. PCEs 6, 7 and 8 within the designated critical habitat have been degraded, although the severity of degradation varies on a site specific basis.

Conservation Role of Critical Habitat in the Action Area

The action area includes most of the Coastal-Puget Sound IRU, including the Puget Sound MU encompassed by and connected to Puget Sound and that portion of the Olympic Peninsula MU encompassed by and connected to Hood Canal and Strait of Juan de Fuca. The draft recovery plan states that maintaining viable populations of the bull trout is essential to the conservation of species within each of the core areas, IRU, and the coterminous listing (FWS 2004b). To maintain or restore the likelihood of long-term persistence of self-sustaining, complex, interacting groups of bull trout within the action area, the FWS has identified the following needs: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas; 2) maintain stable or increasing trends in abundance of bull trout; 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.

FMO areas are central to the survival and recovery of the bull trout. The draft recovery plan states that although use of FMO habitat by bull trout may be seasonal or very brief (as in some migratory corridors), it is a critical habitat element. The plan also states that bull trout need at least the following habitat conditions:

- Water temperatures ranging from -2 ºC to 22 ºC , depending on life history stage and form, geography, elevation, diurnal and seasonal variation, and local groundwater influence (PCE #1).

- Migratory corridors with no physical, biological or chemical barriers between spawning, rearing, overwintering, and foraging habitats (PCE #6).

- An abundant food base including prey items such as: macro invertebrates, crayfish, and forage fish (PCE #7).

- Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival, are not inhibited (PCE #8).

The intended recovery function of critical habitat is to support the core areas and ensure that the habitat requirements of bull trout are met, now and in the future. The primary constituent elements provide a measure of the habitat conditions and are essential components of critical habitat.

10.2 Coastal Cutthroat Trout

In 2000, the WDFW released its Salmonid Stock Inventory (SaSI) Coastal Cutthroat Trout (WDFW 2000) for Washington State. This inventory identified 40 “stock complexes” within Washington State. A stock complex is a group of stocks typically located within a single watershed, or other relatively limited geographic area, and believed to be closely related to one another (WDFW 2000). Of these 40 stock complexes, one was considered to be healthy, 7 were considered to be depressed and the status of the other 32 complexes was unknown (see Table 5.1 in **Status of Coastal Cutthroat Trout**). The 7 depressed stocks are located in the lower

Columbia River area (WDFW 2000). As described above, in 2002, FWS determined that the southwest Washington/Columbia River coastal cutthroat trout population was not warranted for listing under the Act.

The most recent status assessments for coastal cutthroat trout in the Olympic Peninsula and Puget Sound areas is found in Johnson et al. (1999) status review (64 FR 16407) and in the 2000 Washington State Salmonid Stock Inventory (SaSI): Coastal Cutthroat Trout (WDFW 2000). The following status summary for the Action Area is largely based on information from those two reviews.

Puget Sound

Few data exist concerning historical and present abundance of coastal cutthroat trout in Puget Sound and almost no estimates of adult population sizes exist. Anecdotal reports suggest low abundance of coastal cutthroat trout in southwestern Puget Sound. Johnson et al. (1999) concluded that population levels in Puget Sound appear to be relatively stable over the past 10 to 15 years, although many of the populations are believed to be smaller relative to historic levels. Juvenile coastal cutthroat trout are relatively well distributed in the Skagit and Stillaguamish River basins and along the Strait of Juan de Fuca.

Although trends in smolt numbers were mixed in both Hood Canal and southern Puget Sound, increases in smolt numbers in some urban streams coincided with declines in coho salmon abundance. In these streams it is possible that a relaxation of competition with coho has occurred, allowing for an increase in coastal cutthroat trout. To some degree cutthroat trout abundance is determined by interactions with sympatric species, particularly coho salmon. In developed urban watersheds, where alterations of natural flow patterns and water quality have occurred due to the expansion of storm water runoff, the changes in run-off patterns have put fall spawning salmonids at a disadvantage relative to spring spawners (Seiler et al. *in litt.* 2005). In these streams even moderate rainstorms become redd scouring torrents in the fall and winter. Furthermore, lack of wetlands and groundwater storage can result in extreme low summer flows. Because cutthroat trout spawn in the spring as flows are generally declining, their eggs survive at apparently much higher rates than those of coho. In these areas it appears that fall spawners, such as coho, are at a disadvantage to spring spawners, such as coastal cutthroat trout.

Olympic Peninsula

At the time of the 1999 status review, adequate information to estimate population abundances for coastal cutthroat trout in the Olympic Peninsula area was not available (USDC and NMFS 1999). However, the review did find that limited trapping data support the opinions of State and Tribal fisheries biologist that juveniles in this area are well distributed in streams along the western Strait of Juan de Fuca and northern Washington coast. However, hatchery releases of coho salmon fry occur in some areas on the Olympic Peninsula, which may result in increased stress on coastal cutthroat trout due to elevated levels of interspecific competition relative to what occurs naturally.

10.3 Marbled Murrelet

Conservation Needs of the Marbled Murrelet in the Action Area

The Marbled Murrelet Recovery Plan (FWS 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 in 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 Geoduck HCP is located entirely within Conservation Zone 1 (Puget Sound Zone) and includes nearshore marine habitats. The recovery plan has identified all waters of the Puget Sound, the Strait of Juan de Fuca, the San Juan Islands, and river mouths in those areas as essential for marbled murrelet loafing and foraging.

Likelihood of Species Presence in the Action Area

Marbled murrelet presence in the action area is documented by several sources. The most precise information comes from boat surveys conducted by the USFS, Pacific Northwest Research Laboratory to determine population size and trends under the Northwest Forest Plan Marbled Murrelet Effectiveness Monitoring Program. The action area for the proposed Geoduck HCP occurs in all 3 strata in Conservation Zone 1 (Puget Sound Zone)(see Figure 10.3.1). Each stratum is divided into "Primary Sampling Units" or PSUs. Each PSU is a rectangular area approximately 12.4 mi (20 km) long composed of inshore and offshore subunits. PSUs are sampled between May 15 and July 31 (Bentivoglio et al. 2002). Density estimates for these data are compiled by the Marbled Murrelet Effectiveness Monitoring team by strata. Across years in stratum 1, murrelet densities have ranged from 0.010 to 0.029 birds per acre (birds/ac) (2.50 to 7.19 birds per square kilometer (birds/km^2)). Across years in stratum 2, murrelet densities have ranged from 0.0045 to 0.0098 birds/ac (1.12 to 2.43 birds/km^2). And across years in stratum 3, murrelet densities have ranged from 0.0032 to 0.0084 birds/ac (0.79 to 2.07 birds/km^2). Across years over all strata in the Zone, summer murrelet densities have ranged from 0.0063 to 0.011 birds/ac (1.56 to 2.78 birds/km^2) (Table 10.3.1).

Table 10.3.1 Average Summer At-Sea Densities of Marbled Murrelets (birds/ km^2) in Conservation Zone 1, Strata 1, 2, and 3, based on Effectiveness Monitoring for the Northwest Forest Plan.

Year	**Density (birds/km^2)**				**Source**
	Stratum 1[1]	Stratum 2[2]	Stratum 3[3]	All Strata	
2000	3.37	1.12	1.01	1.61	Huff et al. 2003
2001	4.51	1.76	2.07	2.55	Huff et al. 2003
2002	7.19	1.86	0.97	2.78	Huff et al. 2003
2003	6.64	1.44	0.79	2.43	Lance 2004
2004	3.83	1.52	0.29	1.56	Falxa et al. 2008
2005	2.50	2.43	2.02	2.28	Falxa et al. 2008
2006	2.76	1.41	1.28	1.69	Falxa et al. 2008
2007	3.45	1.22	1.80	2.00	Falxa et al. 2008
All Years (avg.)	4.28	1.60	1.28	2.11	

[1]Stratum 1 overlaps all of the Strait of Juan de Fuca Geoduck Management Region
[2]Stratum 2 overlaps all of the San Juan Islands Geoduck Management Region, all of the North Sound Geoduck Management Region, a portion of the Central Sound Geoduck Management Region, and a portion of the Hood Canal Geoduck Management Region.
[3]Stratum 3 overlaps a portion of the Central Sound Geoduck Management Region, a portion of the Hood Canal Geoduck Management Region, and all of the South Sound Geoduck Management Region.

The WDFW, in cooperation with the PSAMP also conducts winter and summer 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. For the purposes of this consultation, we are using only their winter information, since we already have summer density information from the Effectiveness Monitoring program (Table 10.3.1). In the action area, PSAMP winter aerial surveys have documented densities ranging from a minimum of 0.00049 to 0.22 birds/ac (0.12 to a maximum of 55.29 birds/km^2) (WDFW 2005b), with mean densities of 0.00085 to 0.0081 birds/ac (0.21 to 2.00 birds/km^2) (Table 10.3.2).

Table 10.3.2 Minimum, Maximum, and Mean Winter Densities of Marbled Murrelets (birds/ km^2) by Geoduck Management Region. Source: PSAMP winter surveys, 1993-2005.

	Density (birds/km^2)					
	Strait of Juan de Fuca	San Juan Islands	North Sound	Central Sound	South Sound	Hood Canal
Minimum	0.21	0.16	0.19	0.14	0.12	0.17
Maximum	13.53	55.29	14.79	10.49	5.25	5.53
Mean	2.00	0.21	1.64	1.76	0.70	1.00

Based on the information described above, the FWS expects that marbled murrelets will be in the action area year-round in higher average (mean) densities in Stratum 1 (Strait of Juan de Fuca Geoduck Management Region), but relatively lower densities in Strata 2 and 3 (all other Geoduck Management Regions).

Another way to look at the data is to compare summer and winter side by side. Because the strata from the Effectiveness Monitoring effort do not coincide with the Geoduck Management Regions, it is an imperfect comparison (Table10.3.3). Overall, year-round densities average about 0.0081 birds/ac (2 birds/km^2).

Table 10.3.3 Average Summer (2000-2007) and Winter (1993-2005) Densities (birds/km^2) of Marbled Murrelets in the Action Area by Management Region.

Geoduck Management Region											
Strait of Juan de Fuca		San Juan Islands		North Sound		Central Sound		South Sound		Hood Canal	
Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
4.28	2.00	1.60	0.21	1.60	1.64	1.28-1.60	1.76	1.28	0.70	1.28-1.60	1.00

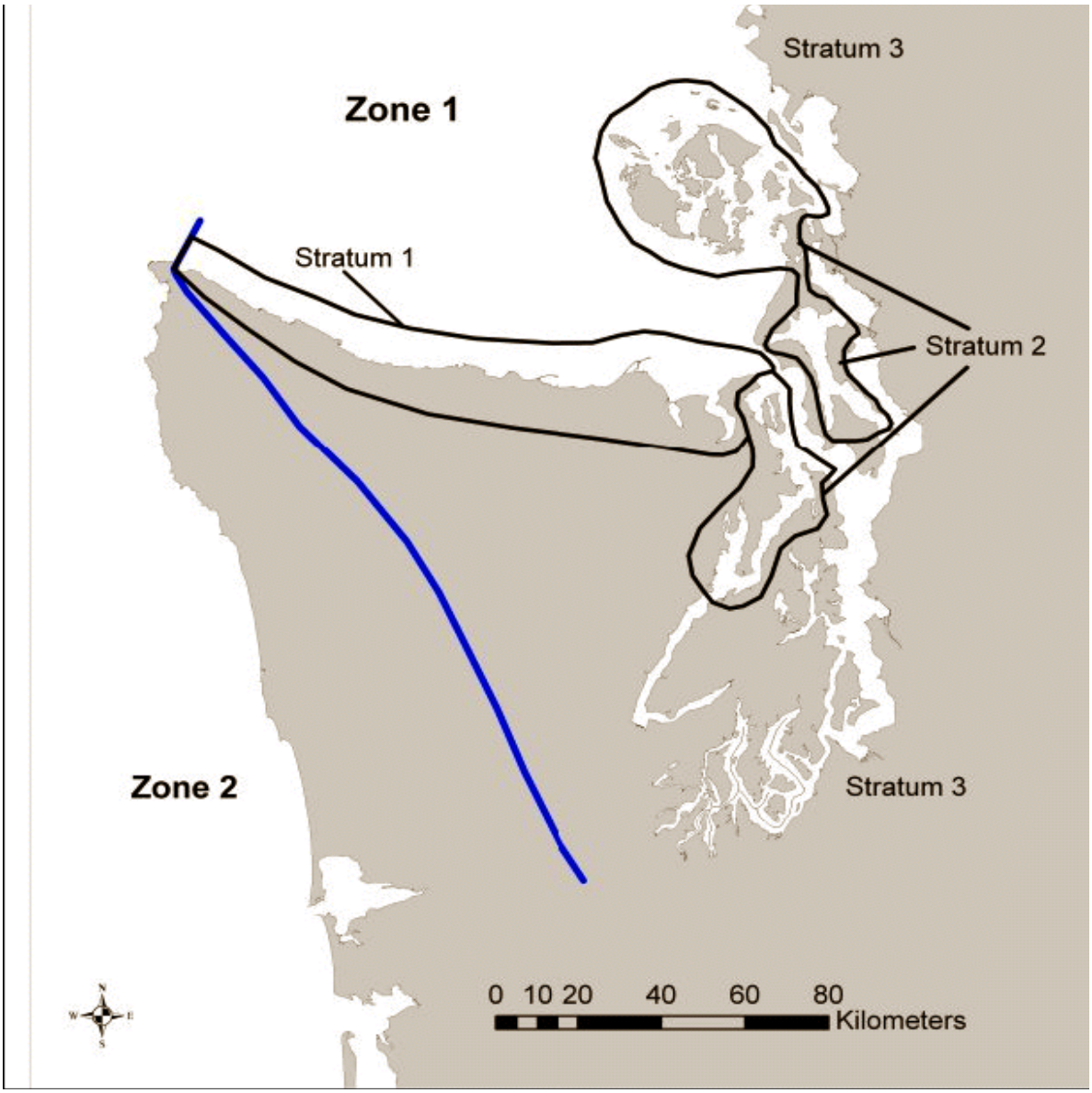

Figure 10.3.1 Within Conservation Zone 1 for marbled murrelets, Strata 1 and 2 are circled, and Stratum 3 comprises the remaining uncircled areas (Bentivoglio 2002).

10.4 California Brown Pelican

Brown pelicans disperse from breeding colonies in late summer and follow food supplies north along the coast. The highest numbers in Washington occur during El Niño years, when food is scarce around their breeding colonies in the south and many birds fail to breed. Birds begin to arrive on the Washington coast in June and their numbers peak in September (WDFW 2004). Their numbers gradually decline in October and early November as birds move south for the winter. Brown pelicans may be found along the outer coast from June to October. Numbers can be high at the mouth of the Columbia River, in Gray's Harbor, at Ocean Shores, and at Copalis National Wildlife Refuge, a collection of coastal islands, rocks, and reefs from Clallam to Grays Harbor County. East Sand Island, near the mouth of the Columbia River, is the largest roost in the Pacific Northwest for brown pelicans. Nearly 11,000 of the endangered birds have been

counted on East Sand Island at one time (WDFW 2004). Brown pelicans in smaller numbers can also be found in Willapa Bay, Grays Harbor, and Puget Sound including the San Juan Islands.

10.5 Bald Eagle – Pacific Population

Bald Eagles in Washington

Watson et al. (2002) determined that the nesting bald eagle population in Washington during the period from 1980 through 1998 had increased at an annual rate of 10 percent as adult eagles have reoccupied habitat vacated during the period of widespread persecution and DDT use. Productivity and nest success of bald eagles affected by contaminants along Hood Canal and the Columbia River estuary also increased during the study period, and by 1998, the bald eagle population was widely distributed across the state and there were indicators that the population had stabilized (Watson et al. 2002).

There are currently 2,785 bald eagle sites (nest site or communal roost site) in Washington according to the WDFW Priority Habitats and Species database (WDFW 2007b). The majority of these sites are nest sites. Not all nest locations are likely to be currently occupied, because many bald eagle territories have multiple nest sites. Other nest sites may no longer exist due to blowdown, decay, or other causes, although these sites may not yet have been removed from the WDFW database that tracks nest sites and wintering areas. In 1998, WDFW estimated there were 664 occupied nests in the state, with a wintering population of 3,500 to 4,000 bald eagles (Stinson et al. 2001). Population modeling completed by Watson et al. (2002) indicated an ecological carrying capacity of 733 breeding pairs in Washington, suggesting the available habitat in Washington may be nearing saturation. The breeding population of bald eagles in Washington has increased steadily in the past 20 years, and two-thirds of these nest sites are located on private lands. Only about 10 percent of bald eagle nests are on lands where their habitat could be considered secure in the absence of habitat protection rules (i.e., National Parks, Wildlife Refuges, etc.).

Bald Eagles Adjacent to Geoduck Harvest Tracts

We used GIS to estimate the number of bald eagle sites (nests and communal roosts) that are located in close proximity to geoduck harvest tracts. Bald eagle sites are based on point locations documented in the WDFW Priority Habitats and Species database. Based on management recommendations listed in the Pacific Bald Eagle Recovery Plan (FWS 1986), we selected 0.5 mile and 0.25 mile radius circles to identify the number of bald eagle sites that are in the vicinity of the proposed action. It is important to note that all values reported here are general estimates based on our interpretation of the GIS data and are not intended to be interpreted as absolute values. Of the 2,785 bald eagle sites documented in Washington, 370 sites are located within 0.5 miles of a commercial geoduck harvest tract. Of these, only 178 sites are located within 0.25 miles of a commercial geoduck harvest tract.

10.6 Tufted Puffin

Only tufted puffin in Conservation Zone 1, the Washington State inland marine management regions of North Puget Sound, Central Puget Sound, Hood Canal, South Puget Sound, Straight of Juan de Fuca, and San Juan Islands, are within the boundaries of the proposed action.

The estimated population of tufted puffins in Washington State is 22,300 individual tufted puffins and 16 colonies (Piatt and Kitaysky 2002). This estimate mostly reflects birds in Conservation Zone 2, the Washington coastal population outside the action area. Total tufted puffin distribution and abundance is difficult to determine in Washington's inland waters (Conservation Zone 1) due to few recent censuses and literature. In 1989 an estimated 8,760 breeding tufted puffins were found within the inland waters of Washington. North Puget Sound, San Juan Islands, and the eastern Strait of Juan de Fuca had 60 breeding tufted puffins and the western Strait of Juan de Fuca and northern tip of the Washington coast (the coastal area is outside the action area) had 8,700 breeding tufted puffins (Speich and Wahl 1989). The population estimate is now thought to be much lower.

Puget Sound

Tufted puffins and their nesting colonies are absent in South Puget Sound and Hood Canal. In the North Puget Sound, which includes the waters between the Strait of Juan de Fuca and the San Juan Islands, tufted puffins have been observed swimming and foraging. A tufted puffin nesting colony exists on Smith Island (Speich and Wahl 1989), but the current status is not known (A. Schmidt FWS pers. comm. with Kevin Ryan, San Juan Islands NWR, 2006). Smith Island population declined from a historic high of 500 tufted puffins to 0 in 1986, but 6 were sighted in 2001 (Piatt and Kitaysky 2002). No commercial geoduck harvest tracts are located in the vicinity of Smith Island.

Strait of Juan de Fuca

The Strait of Juan de Fuca is a migration route for the tufted puffin from the North Pacific Ocean's coastal waters to the inland waters of the San Juan Islands in Washington State. However, the population is severely reduced within these sheltered waters, including the nesting colony on Protection Island where there were only 18 birds counted in 2001, a -9.4 percent population change per year during the past 15 years (Piatt and Kitaysky 2002).

San Juan Islands

Tufted puffins are observed swimming in the San Juan Islands region, but no estimate of numbers is available. In the past, several tufted puffin nesting colonies were found among these islands including Colville and Bare islands (Speich and Wahl 1989), but it is thought that they have been extirpated (Piatt and Kitaysky 2002). Tufted puffin nesting habitat is abundant in this region, especially within the San Juan Islands National Wildlife Refuge.

Factors affecting the species environment within the action area

Actions already affecting the tufted puffin in Washington's inland waters include fishery gillnets and longlines, pollutants and contaminants, global climate change and sea-surface temperatures, introduced/non-native species, and disease. These elements are described in the status of the species.

11.0 EFFECTS OF THE ACTION

Forage Fishes

Although only one of the species identified in this section is a covered species (Pacific herring, NMFS jurisdiction), forage fish play a key role in the food web of the marine environment. Almost all the covered species in this Opinion depend directly on forage fish and forage fish make up a significant proportion of their diets. Other covered species such as the bald eagle, although they are not directly dependant on forage fish as prey, consume species (salmon) that consume forage fish. As such, it is important to discuss the status of these important forage fish and the effects the proposed action have upon them prior to analyzing the effects of the action on the covered species.

Forage fish are loosely defined as small, schooling fishes that form critical links between the marine zooplankton community and larger predatory fish, seabirds, and marine mammals in the marine food web (Penttila 2007; Puget Sound Action Team 2007). They feed mainly on zooplankton and phytoplankton and reside in the upper levels of the water column and nearshore areas (Puget Sound Action Team 2007). The three most common forage fish species found within the area of geoduck harvest are Pacific herring (*Clupea pallais*), surf smelt (*Hypomesus pretiosus*), and Pacific sand lance (*Ammodytes hexapterus*). These three fish and their critical spawning habitats, all commonly occur within the nearshore zone of Pacific Northwest beaches. Within the Puget Sound basin, where their critical spawning habitats have been most completely mapped, each species appears to use approximately ten percent of the shoreline for spawning habitat during the year (Penttila 2007). Some species tend to use the same beaches annually. All three species use the nearshore habitats adjacent to spawning areas as nursery grounds (Penttila 2007). Three other, less important, species; northern anchovy (*Engraulis mordax*), eulachon or Columbia River smelt (*Thaleichthys pacificus*) and longfin smelt (*Spirinchus thaleichthys*), also contribute to the overall biomass of forage fish in the Puget Sound region (Penttila 2007).

Pacific Herring

WDFW recognizes 19 different stocks of Pacific herring in Puget Sound, based on the timing and location of spawning activity (Puget Sound Action Team 2007; WDNR 2001; WDFW 2000). The grounds are well defined and the timing of spawning very specific, seldom varying more than seven days from year to year (WDFW 2000b). Pacific herring spawn by depositing their eggs on eelgrass, algae, hard substrates, and occasionally on the amassed beds of tubes of the polychaete worm (*Phyllochaetopterus sp*.)(Penttila 2007). Most egg deposition occurs from +3 to -15 feet in tidal elevation, but in some areas spawning can occur as deep as -40 to -60 feet (WDNR 2001). The eggs incubate for 10 to 14 days prior to hatching. Following hatching, the

larvae drift in the currents. Following metamorphosis, young herring spend their first year in Puget Sound; some then spend their entire lives within Puget Sound, while others migrate to the open ocean as they become larger. After reaching sexual maturity (2-4 years), herring migrate back to the spawning grounds. Most spawning occurs between mid-January and March. The Cherry point stocks spawns slightly later; during April to June (WDFW 2000b).

Surf Smelt

Surf smelt are common resident fish in many parts of Puget Sound. They appear to be relatively short-lived fish with most spawning populations comprised of one- and two-year old fish. Spawning occurs at high tides on mixed-sand and gravel substrates in the upper tidal zone generally higher than + 7 feet in tidal elevation. Smelt eggs incubate for two to six weeks (WDFW 2000). They are a visual sight feeder feeding on plankton/macro-zooplankton, primarily arthropods, and are closely associated with the shoreline, spending their entire lives shoreward of the -10 fathom contour (60 ft). There is no information on adult movement patterns; however, there is no evidence of seasonal ocean-ward migration out the Strait of Juan de Fuca, like there is for Pacific herring. Their home ranges are unknown and there has been no assessment of stock status.

Surf smelt spawn year-round in a number of areas in Puget Sound. The WDFW has documented spawning habitat on 195 lineal statute miles of Puget Sound shoreline; however, surveys are incomplete due to budget cuts since 1997 (Bargmann 1998). At this time, there is little concern over the overall status of Puget Sound surf smelt stocks (Bargmann 1998).

Pacific Sand Lance

Pacific sand lance spawning is confined to the upper tidal zone, generally higher than + 5 feet in tidal elevation. Pacific sand lance spawning season occurs from November to February. The incubation period for Pacific sand lance eggs is about 30 days (WDFW 2000). Pacific sand lances exhibit a diurnal behavior of feeding in the open water column during light hours and burrowing into soft sand-gravel substrates during the dark hours. Pacific sand lance are common, year-round residents of the nearshore areas of Puget Sound. They are visual sight feeders, feeding on plankton/macro-zooplankton, primarily arthropods. Schools can be commonly encountered in waters over 100 feet deep. However, juveniles may be more closely associated with shorelines and protected bays in mixed schools with herring and surf smelt of similar age and size (Penttila 2007). There is no information on adult movement patterns; however, there is no evidence of seasonal ocean-ward migration out the Strait of Juan de Fuca, like there is for Pacific herring. Their home ranges are unknown and there has been no assessment of stock status.

The WDFW has documented spawning habitat on 129 lineal statute miles of Puget Sound shoreline; however, surveys are incomplete due to budget cuts since 1997 (Bargmann 1998). Several spawnings may occur at any given spawning site during the November-February

spawning season. Pacific sand lance use the same stretches of beach as surf smelt, at the same times of year (Bargmann 1998).

Other forage fish

Northern anchovy (*Engraulis mordax*) are pelagic schooling fish that spawn and incubate eggs in open water. Eggs float in the upper water layers and hatch in 2 to 4 days (Hart 1973). Northern anchovies have been found in Puget Sound over the past decade and their geographical distribution and abundance seem to be expanding (Puget Sound Action Team 2007). Eulachon or Columbia River smelt (*Thaleichthys pacificus*) and longfin smelt (*Spirinchus thaleichthys*) spawn in freshwater gravels and its non-spawning life stages may occur in the marine nearshore.

Puget Sound forage fish populations are not generally considered to be threatened or endangered. Two petitions to list Puget Sound herring stocks as threatened or endangered under the Act in recent years have not been successful due to insufficient information (Penttila 2007). Little is known about any of these fishes away from their spawning grounds. Herring, the only species to be monitored by the state, appear to be either resident or migratory, but generally do not persist as large schools in the nearshore environment after spawning. The other species have not been monitored throughout Puget Sound. While two significant herring stocks, late-run Cherry Point and Discovery Bay, have suffered significant declines in biomass in recent years, their declines have been partially matched by increases in the estimated biomass of other Puget Sound stocks. This has resulted in a relatively flat trend in total Puget Sound spawner-herring abundance for about the last 20 years (1974-2004)(Penttila 2007). More recent declines have been observed in the past five years (Puget Sound Action Team 2007). The statuses of the other forage fishes are currently unknown, for lack of cost-effective methods to assess them (Penttila 2007).

Conservation Measures Pertaining to Forage Fish

Due to the recognized importance of eelgrass, the potential damage to eelgrass that could result from geoduck harvest, and based on the recommendations of WDFW habitat biologists; geoduck harvest is not permitted in any eelgrass beds. This is stipulated in State/Tribal management agreements and harvest plans, and is accomplished by doing pre-harvest eelgrass surveys along the entire shoreward perimeter of all geoduck tracts to find the deepest growing eelgrass. The shoreward boundary of the geoduck tract is then set seaward of the deepest rooted eelgrass blade. State/Tribal harvest plans stipulate that where eelgrass is deeper than -18 ft (MLLW), the shoreward boundary of the tract will be two vertical feet deeper and seaward of the deepest occurrence of eelgrass. Alternately, a buffer zone of at least 180 feet around eelgrass beds deeper than -18 ft (MLLW) can be used when the perimeter of the zone is marked and visible to divers within the tract. This provides a buffer between geoduck harvest and eelgrass. The shoreward boundary is then enforced by WDNR and Tribal enforcement crews. In addition, within one year after obtaining the Incidental Take Permits, WDNR is required to contact appropriate WDFW and Tribal biologists and arrange a meeting for the purposes of assessing and reaffirming that buffers in the Geoduck HCP are adequate to protect nearshore environments, eelgrass, and herring spawning areas.

During the preharvest surveys, tracts are also inspected for important fish habitats, and the presence of different species of marine fish is noted on a transect-by-transect basis. These data are included in Environmental Assessments and provided to WDFW biologists in the Marine Fish and Freshwater Fish Division. These marine fish and salmon biologists review the proposed harvest sites on a site-by-site basis and identify potential conflicts.

Herring spawning area buffer – WDNR will protect herring spawning habitat and macroalgae habitat that may provide cover for other fish, and avoid disturbing herring during spawning times by establishing shoreward harvest boundaries. On tracts adjacent to documented herring spawning areas (eelgrass, macroalgae, or other substrate), the shoreward harvest boundary will be restricted to waters deeper than - 35 feet MLLW during spawning season and deeper than -25 feet MLLW during the remainder of the year (WDNR 2008).

Other forage fishes – Shoreward tract boundaries along the -18 feet MLLW depth contour protect intertidal habitats used by sand lance and surf smelt as spawning areas (WDNR 2008). Sand lance and surf smelt spawning is confined to the upper tidal zone, generally higher than plus seven feet in tidal elevation (Penttila 2007). This habitat includes eelgrass, macroalgae, other vegetation and beaches. Buffers around eelgrass and other vegetation help protect these potential cover and food sources.

Effects

Pacific herring are the species most likely to spawn on or near commercial geoduck tracts. Herring spawning areas are well documented. Spawning occurs between January and June based on stock and location. The spawning and/or prespawner holding areas of 11 stocks largely overlap currently-surveyed geoduck tracts. Small portions of another four stocks also overlap current geoduck tracts. Four other stocks do not overlap current geoduck tracts (WDFW 2008).

Generally, spawning occurs inshore of geoduck harvest tracts between +3 feet and -15 ft MLLW. Geoduck harvest is limited to depths below -18 feet MLLW to avoid the majority of herring and other forage fish spawning habitats. On tracts adjacent to documented herring spawning areas (eelgrass, macroalgae, or other substrate), the shoreward harvest boundary will further be restricted to waters deeper than -35 ft MLLW during the spawning season and deeper than -25 ft MLLW feet during the remainder of the year. Most egg deposition occurs from +3 to -15 feet in tidal elevation, but in some areas spawning is known to occur as deep as -40 to -60 feet MLLW (WDNR 2001). Fifty-five of the total 371 identified geoduck tracts are known to have spawning on or near them at depths greater than -15 ft MLLW. On these tracts, geoduck harvest allowed during the herring spawning season could preclude herring from spawning in the immediate vicinity of the divers, deposited eggs could be dislodged by divers and equipment, spawning substrate could be damaged, and/or eggs could be covered by suspended sediments. Even with the additional depth restrictions to address known spawning areas in or adjacent to geoduck tracts, we anticipate that herring spawning and deposited eggs below -35 feet MLLW could be adversely affect by harvest activities. We expect that a small proportion of the spawning population and herring eggs could be affected by the proposed action through disturbance of spawners and spawning substrates or the deposition of sediment on eggs.
Spawning and spawning habitat of other forage fish will be unaffected by the project. Pacific

sand lance and surf smelt spawn generally from the mean high tide line to about +5 feet in tidal elevation (WDFW 1998b), which are outside the boundary of the proposed geoduck harvest. Northern anchovy (*Engraulis mordax*) are pelagic schooling fish that spawn and incubate eggs in open water. Eulachon or Columbia River smelt (*Thaleichthys pacificus*) and longfin smelt (*Spirinchus thaleichthys*) spawn in freshwater gravels.

Injury and or mortality to juvenile and adult forage fish from sediment are not anticipated. There is little literature that documents the effects of sediment on forage fish in the marine environment. Forage fish spawn and rear along naturally turbid shorelines and are frequently exposed to natural sediment plumes entering Puget Sound via freshwater tributary streams (NMFS pers. comm. with Dan Penttila 2008). Sediment plumes associated with these run-off events are typically large and persist for several days. Suspended sediments generated by geoduck harvest are magnitudes smaller (Short and Walton 1992). Increases in turbidity due to hydraulic clam harvesting averaged 1 mg/L above the background range of 8 to 25 mg/L 300 feet down-current of harvest activities (Tarr 1977; Short et al. 1992). Generally, hydraulic clam harvesting is considered more invasive than geoduck harvesting employing divers with hand-held water jets. The level of turbidity at any geoduck tract depends on the type of substrate present where the harvest occurs, but such levels are well within natural turbidity levels typically experienced by forge fish. Water currents also play a role in turbidity, affecting the time needed for dispersal and distance traveled of suspended material (WDNR 2008).

Temporary displacement of forage fish from sediment plumes may occur during harvest activities. Sediment plumes from geoduck harvest activities originate from the substrate and dissipate in the water column as they move away from the site of origin and currents act upon them. Although forage fish feed mainly on zooplankton and phytoplankton and tend to reside in the upper levels of the water column and nearshore areas (Puget Sound Action Team 2007), they may still be exposed to sediment plumes especially during low tides and when divers are working in the upper elevations of a particular tract. Forage fish are mobile and capable of avoiding turbidity generated by harvest activities. Plumes dissipated within a few hundred feet down-current of hydraulic clam harvesting (Tarr 1977). Generally, hydraulic clam harvesting is considered more invasive (i.e. generates more sediment) than geoduck harvesting that employs divers with water jets (Short et al. 1992). Turbidity generated from geoducks harvest is localized and tends to be short-lived. Suspended sediments from individual geoduck harvest holes settle out within a few hours and holes fill in and consolidate within 24 hours (WDNR 2007 video). Harvest activities on a particular tract do not occur year-round as harvest is intentionally rotated between tracts and regions. On a typical harvest day, 2.16 to 4.65 acres of seafloor will be disturbed.

Limited disturbance to the benthic community of 2.16 to 4.56 acres on harvest day will have little effect on forage fish's ability to feed. Forage fish feed mainly on zooplankton and phytoplankton and feed in the upper levels of the water column and nearshore areas (Puget Sound Action Team 2007). Benthic species displaced by geoduck harvest activities are not typically consumed by forage fish.

Summary

Forage fish utilize the nearshore habitats throughout Puget Sound for spawning and rearing. Most spawning and rearing of the three major forage fish that overlap geoduck harvest areas (herring, surf smelt, sand lance) occur at depths between +5 feet and -15 ft MLLW. Some Pacific herring spawning has been documented at depths below this range; however these are infrequent occurrences. Conservation measures in the Geoduck HCP are designed to avoid areas landward of -18 feet MLLW. In geoduck harvest tracts where there is documented herring spawning below -18 feet MLLW, this restriction extends down to -35 feet MLLW during the spawning season and -25 feet MLLW during the rest of the year. These restrictions should adequately protect a significant proportion of the spawning and rearing areas used by forage fish in Puget Sound. In some limited situations, where spawning has been documented to occur below -35 feet MLLW herring spawning activities may be temporarily precluded and deposited eggs could be covered with silt resulting in a small, but unquantifiable, amount of egg mortality. In addition, if determined by WDFW and Tribal biologists, spawning areas below -35 feet MLLW may be closed to harvest or closed seasonally to protect spawning periods or other critical times.

Direct effects on adult fish from sediment are not anticipated. Sediment plumes dissipate readily in an active marine environment. Plumes originate from harvest activities along the bottom; forage fish tend to feed in the upper levels of the water column or in the nearshore environment. Forage fish are mobile and because the activity and turbidity will be short-term and localized, forage fish will likely avoid the area during the activity and return after the activity has ceased. A small amount of Pacific herring egg mortality and the temporary displacement of adult forage fish during geoducks harvest activities is anticipated, but adverse effects to forage fish populations at the tract level or within the action area are not anticipated.

11.1 Effects of the Action – Bull Trout

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 direct effects of the proposed project derive from the nature, extent, and duration of geoduck harvest activities in the water and whether bull trout or forage fish are migrating or foraging at that time.

Vessels
Harvest vessels and WDNR compliance vessels are on the water during harvest operations. The number of boats participating in the geoduck fishery at one time ranges between eight and ten. The noise and general activity from the vessels could potentially disturb bull trout in the area where harvest occurs. Geoduck harvest operations generate noise from two sources; the vessel engine and the pump or compressor engines. Engine noise increases temporarily when boats are repositioned on the tract.

On site measurements found maximum surface noise levels of 50 to 61 dBA at a distance of 100 feet. From a point source in a uniform medium (water or air), sound spreads outward in spherical waves. 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. Harvesting agreements require vessels to operate at surface noise levels less than 50 decibels measured at 200 yards from the source. This level is less than the state standard and is well below levels expected to result in physical injury to aquatic organisms. Noise levels might cause individual bull trout to avoid portions of the harvest tract, although we do not expect this to significantly disrupt normal behavior patterns.

Vessels pose a risk of fuel spills or spills of other hazardous materials that could damage habitat or kill individual fish. These risks are reduced through a number of measures required by DNR and include compliance with all Federal, State and local laws and regulations concerning the use and disposal of hazardous, toxic or harmful substances; WDNR's right to enter and inspect any harvest vessel; and the requirement of any harvest vessel in danger of capsizing, or with obvious leaks of toxic or hazardous substances to return to the docks for repairs. In the past 10 years Todd Palzer, WDNR Shellfish Operations Manager, has received no notice or documentation of any oil or fuel spills occurring related to geoduck harvest, and he is not aware of any events prior to that time (T. Palzer, pers. comm. 2008). However, given the 50-year term of the action, we have determined there is a likelihood of a single oil or fuel spill event. Given the size of the vessels involved, we expect such a spill event to be of relatively small magnitude (i.e., $\leq$ 500 gallons). We do not anticipate direct exposure of bull trout to such a spill event given the anticipated size of such an event, and the typically benthic/bottom oriented nature of bull trout within the marine nearshore, nor do we anticipate indirect effects via prey resources to rise to the level of significantly disrupting normal foraging behaviors of bull trout.

Harvest activities

The Geoduck HCP occurs within the marine nearshore waters of Puget Sound, Hood Canal, the Strait of Juan de Fuca and areas south of the Canadian border. Within this broad area geoduck harvest occurs subtidally in areas that have been surveyed between depth contours of -18 and -70 feet (corrected to mean lower low water [MLLW] and found to contain geoducks at sufficient densities for harvest.

The total acreage of surveyed tracts fluctuates some, but is about 30,000 acres. Individual tracts range in size from 4 acres to 1,197 acres, but most (more than 60 percent) are less than 200 acres in size. Commercial harvest occurs year-round on the subtidal geoduck tracts identified as able to support commercial harvest. It can take up to seven years to complete harvest on one commercial geoduck tract over the course of several harvest cycles. Although the fishery operates year-round, harvest activities on a particular tract do not occur year-round because harvest is intentionally rotated around different regions. Future surveys may result in additional tracts being designated for commercial harvest. For purposes of the HCP, no more than 6,000 acres will be harvested during any one year and no more than 1,500 acres will be harvest from any region per year. This is the combined tract sizes on which harvest activity would occur; however, due to the rotations and cycles described above, the actual amount of tract area experiencing harvest would be less than the 6,000 acres total.

In a recent acoustic telemetry study, depths of bull trout were recorded by mobile tracking and found to occur within the harvest area depths (Goetz et al. 2004b). In general, larger fish tend to

be at greater depths than smaller fish, fish are at deepest depths during the day, and most fish reside within the photic zone (10 meters or less). For one large individual fish that was tracked during a telemetry study, the changes in depth would coincide with variable offshore position during the day and inshore movement during dusk, then moving offshore again at dawn. The average depth of this fish was 12 meters, with a range of 5-25 meters. Although bull trout have not been observed by WDFW divers during geoduck tract pre-harvest flora and fauna surveys, the depths of bull trout observed in the acoustic telemetry study show bull trout movements within the depths of geoduck harvest.

When bull trout occur at depths within the range of geoduck harvest, it is likely that they are either foraging or migrating. Anadromous bull trout are opportunistic feeders and utilize forage fish species (surf smelt, Pacific herring, and Pacific sand lance) almost exclusively when they are present in the nearshore marine habitats (R2 Resource Consultants 2003). Although spawning sites for these forage fish have been identified in a number of locations, little is known about any forage fish away from their spawning grounds other than that they are small, schooling fish that are key prey items for larger predatory fish and wildlife (Penttila 2007).

During geoduck harvest the divers use a water jet to loosen the material around the geoduck. As the geoducks are harvested, holes are created by the removal of the clam, displacement of sediments, and by suspension of fine particles. Thousands of geoducks are harvested from each tract and an estimate of 10,000 holes per acre was calculated based on geoduck landing records as representative of the number of holes dug per acre during harvest (WDFW and WDNR 1985*)*. Geoducks are commonly concentrated in patches, and the actual area where harvest occurs is primarily in these patches.

Effects of geoduck harvest on water quality will likely result from suspension of bottom sediments into the water column. Material is suspended by the action of the water jet, harvest divers walking or swimming near the bottom, and the dragging of hoses and bags of geoducks. The time the particles remain in the water column depends on their size (small particles remain suspended longer than larger particles), the amount of mixing and lifting, and the velocity of the water column.

The effects on water quality from the harvest activities can have a detrimental impact on salmonids. Suspended sediments can have an adverse effect on migratory and social behavior as well as foraging opportunities (Berg and Northcote 1985; Bisson and Bilby 1982; Sigler et al. 1984). 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. Chemical composition of the water with suspended sediments is also affected by turbidity. Estuarine sediments are typically anaerobic and create an oxygen demand when suspended in the water column, which in turn decreases dissolved oxygen (DO) levels (Hicks et al. 1991; Morton 1976). 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 dissolved oxygen could directly affect bull trout's ability to escape potential predation or could affect their ability to forage. Lasalle (1988) found a decrease in DO levels from 16 to 83 percent in the mid-to-upper water column and nearly 100 percent closer to the bottom during dredging operations. Since bull trout are generally more benthic/bottom-oriented within the water column, this

extreme decrease in DO during dredging operations could directly affect bull trout's ability to survive. Other potential mechanisms by which harvest activity and the related increases in sediment plumes and turbidity could affect bull trout include sublethal effects (stress, gill damage, and increased susceptibility to disease) and behavioral responses (disruptions to feeding or migration). However, the magnitude and duration of turbidity and sediment plumes generated from geoduck harvest are not expected to be as severe as what is produced during dredging operations and, although they are likely to adversely affect bull trout, they are not expected to rise to the level of affecting survival. Furthermore, bull trout are mobile and because the activity and turbidity will be short term and localized, most individual bull trout will likely avoid the area.

While it is possible that the action may force bull trout to migrate to waters where there are less foraging opportunities and/or greater risks of predation, we do not expect this action to typically result in significant disruption of normal behavior patterns. We do not expect significant disruption to frequently occur given the amount of available foraging habitat within the marine nearshore and the scope and duration of the stressor. However, over the course of the 50-year Permit, and given the likely decline in the overall quantity of high quality foraging habitat within Puget Sound in the future, there is a likelihood that significant disruption of normal behavior patterns will occasionally occur to individual bull trout.

Disruption of the substrate by the water jets used during geoduck harvest will have a temporary, negative impact on the benthic community. The majority of infauna resides within the top 12 inches of the benthos and is likely to be directly affected by both mobilization of, and temporary changes in, the matrix of sediments in the harvest areas. These small-scale disturbances of the seabed sediments and morphology are likely to result in short-term effects on the benthic community. Filter feeding benthic organisms exposed to increased sediments can suffer from clogged feeding structures, reduced feeding efficiency, and increased stress levels (Hynes 1970). Based on studies of benthic recolonization related to dredging, we expect the benthic community to recolonize and recover quickly after harvest (WNDR 2008). The affected area represents a very small percentage of the marine foraging habitat available to bull trout in the action area; therefore, significant disruptions to foraging bull trout are not anticipated to occur.

We expect that the amount of increased turbidity to be expected from the proposed geoduck harvest will have no significant impacts to forage fish. See the Forage Fish section for a discussion of impacts to forage fish.

Summary

Geoduck harvest activity will cause localized reductions in water quality from suspended sediments and a decrease in benthic organisms. Sediment plumes associated with diver activity create discoloration of the water, reduce visibility, and change the chemical characteristics of the water. Although the HCP allows a 6,000 acre maximum tract acreage from which harvest could occur annually, harvest activities on a particular tract do not occur year-round because harvest is intentionally rotated around different regions, precluding the likelihood that harvest would be concentrated in an area adjacent to any one core population. While short-term adverse effects to bull trout associated with the harvest activities are possible over the 50-year term of the Permit,

these effects are expected to be temporary, very site specific, and only affect a small percentage of bull trout present in marine waters. Bull trout are widely dispersed within nearshore marine waters of Puget Sound and are highly mobile, capable of accessing broadly distributed foraging habitats. For example, a recent study in the Nooksack found bull trout from that core area migrating to Skagit Bay (approximately 40 miles) (Goetz *in litt.* 2007). Bull trout encounters with harvest activities are anticipated to be infrequent, and although the activities may significantly disrupt individual bull trout's normal behavior patterns associated with feeding and migration, they are not expected to rise to a level that would affect the long-term health or persistence of bull trout core populations within the action area. Effects of vessel activity (noise and potential spills) and impacts to the benthic community are likely to be short term in duration and are expected to result in insignificant effects to bull trout.

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. Human activities and/or land use in the project area would not be altered in the long-term. There are no new developments, industrial uses, or harvest of marine resources (other than associated with the WDNR geoduck harvest) planned for the site that would be caused by the action.

Effects of the Action on Bull Trout Critical Habitat

In some situations, the activities associated with geoduck harvest are expected to result in effects to bull trout critical habitat. Activities covered by the WDNR Low-Effect Geoduck HCP that have the potential to generate effects to nearshore marine areas designated as critical habitat include vessel and harvest activities. Impacts to critical habitat include the temporary elelevation of sediment levels from diver activities and the temporary disruption of migratory corridors from diver and vessel activities.

The PCEs for marine nearshore apply to areas designated as FMO habitat. Only the PCEs described in paragraphs (i), (vi), (vii), and (viii) of the final rule (70 FR 56212) apply to marine nearshore waters identified as critical habitat. Implementation of the proposed action has the potential to adversely affect two of the four PCEs, depending on the location of the critical habitat and its relation to the location of harvest activities on covered lands. The PCEs most likely to be adversely affected by the HCP are PCEs vi and viii.

> (vi) *Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.*
>
> Estuarine sediments are typically anaerobic and create an oxygen demand when suspended in the water column, which in turn, decreases dissolved oxygen (DO) levels (Hicks et al. 1991; Morton 1976). A temporary reduction in DO can render the habitat unsuitable for bull trout migration for short periods of time. Bull trout are widely dispersed within nearshore marine waters of Puget Sound and are highly mobile, capable

of avoiding areas affected by increases in suspended sediment. Bull trout encounters with harvest activities are anticipated to be infrequent, and although the activities may significantly disrupt individual bull trout's normal behavior pattern of migration, they are not expected to rise to a level that would affect the long-term health or persistence of bull trout core populations within the action area. In addition, turbidity generated from geoducks harvest is localized and tends to be short-lived. Suspended sediments from individual geoduck harvest holes settle out within a few hours and holes fill in and consolidate within 24 hours (WDNR 2007 video). Harvest activities on a particular tract do not occur year-round as harvest is intentionally rotated between tracts and regions.

(viii) *Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.*

Estuarine sediments are typically anaerobic and create an oxygen demand when suspended in the water column, which in turn, decreases dissolved oxygen (DO) levels (Hicks et al. 1991; Morton 1976). A temporary reduction in DO can render the habitat unsuitable for bull trout foraging for short periods of time potentially affecting growth and survival of bull trout in the marine environment. Bull trout are widely dispersed within nearshore marine waters of Puget Sound and are highly mobile, capable of accessing broadly distributed foraging habitats. Bull trout encounters with harvest activities are anticipated to be infrequent, and although the activities may significantly disrupt individual bull trout's normal behavior pattern associated with feeding, they are not expected to rise to a level that would affect the long-term health or persistence of bull trout core populations within the action area. In addition, turbidity generated from geoducks harvest is localized and tends to be short-lived. Suspended sediments from individual geoduck harvest holes settle out within a few hours and holes fill in and consolidate within 24 hours (WDNR 2007 video). Harvest activities on a particular tract do not occur year-round as harvest is intentionally rotated between tracts and regions.

11.2 Effects of the Action – Coastal Cutthroat Trout

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 direct effects of the proposed project derive from the nature, extent, and duration of geoduck harvest activities in the water and whether coastal cutthroat trout or forage fish are migrating or foraging at that time.

Anadromous bull trout and coastal cutthroat trout share similar habitats and have similar life history characteristics. Both fish are a sub-part of the anadromous group that is also described as "amphidromous," that is, river and lake rearing fish that migrate between fresh water and sea water not exclusively for breeding but also regularly at some other stage of their life cycle (Jacquet 2002). Many coastal cutthroat trout and bull trout are not sexually mature at their first or second return to freshwater (Brenkman et al. 2007; Garrett 1998). They do not frequently

travel into the open ocean, but concentrate in bays, estuaries and along the coast (Behnke 1992; Brenkman and Corbett 2005; Goetz et al. 2004a). Both fish spend lengthy residency in estuaries and nearshore marine areas (6 months or more), although few fish remain in these areas year round. Both fish are opportunistic and highly predaceous. Their diet while in marine waters consists of a wide variety of small marine fish, invertebrates, and terrestrial insects (Jacquet 2002). Both species have likely experienced impacts to their forage base that has occurred as a result of the declining abundance of juvenile salmon (Cederholm et al. 2000).

Vessels

Vessels pose a risk of fuel spills or spills of other hazardous materials that could damage habitat or kill individual fish. These risks are reduced through a number of measures required by DNR and include compliance with all Federal, State and local laws and regulations concerning the use and disposal of hazardous, toxic or harmful substances; WDNR's right to enter and inspect any harvest vessel; and the requirement of any harvest vessel in danger of capsizing, or with obvious leaks of toxic or hazardous substances to return to the docks for repairs. In the past 10 years Todd Palzer, WDNR Shellfish Operations Manager, has received no notice or documentation of any oil or fuel spills occurring related to geoduck harvest, and he is not aware of any events prior to that time (T. Palzer, pers. comm. 2008). However, given the 50-year term of the action, we have determined there is a likelihood of a single oil or fuel spill event. Given the size of the vessels involved, we expect such a spill event to be of relatively small magnitude (i.e., $\leq$ 500 gallons). We do not anticipate direct exposure of coastal cutthroat trout to such a spill event given the anticipated size of such an event and the typically mid-water oriented nature of coastal cutthroat trout within the marine nearshore, nor do we anticipate indirect effects via prey resources to rise to the level of significantly disrupting normal foraging behaviors of coastal cutthroat trout.

Harvest activities

During geoduck harvest the divers use a water jet to loosen the material around the geoduck. As the geoducks are harvested, holes are created by the removal of the clam, displacement of sediments, and by suspension of fine particles. Thousands of geoducks are harvested from each tract and an estimate of 10,000 holes per acre was calculated based on geoduck landing records as representative of the number of holes dug per acre during harvest (WDFW and WDNR 1985). Geoducks are commonly concentrated in patches, and the actual area where harvest occurs is primarily in these patches.

Effects of geoduck harvest on water quality will likely result from suspension of bottom sediments into the water column. Material is suspended by the action of the water jet, harvest divers walking or swimming near the bottom, and the dragging of hoses and bags of geoducks. The time the particles remain in the water column depends on their size (small particles remain suspended longer than larger particles), the amount of mixing and lifting, and the water column speed.

The effects on water quality from the harvest activities can have a detrimental impact on salmonids. Suspended sediments can have an adverse effect on migratory and social behavior as

wells as foraging opportunities (Berg and Northcote 1985; Bisson and Bilby 1982; Sigler et al. 1984). 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. Chemical composition of the water with suspended sediments is also affected by turbidity. Estuarine sediments are typically anaerobic and create an oxygen demand when suspended in the water column, while in turn decreases dissolved oxygen (DO) levels (Hicks et al. 1991; Morton 1976). 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 dissolved oxygen could directly affect coastal cutthroat trout's ability to escape potential predation or could affect their ability to forage. Lasalle (1988) found a decrease in DO levels from 16 to 83 percent in the mid-to-upper water column and nearly 100 percent closer to the bottom during dredging operations. A decrease in DO during dredging operations could directly affect coastal cutthroat trout's ability to survive. Other potential mechanisms by which harvest activity and the related increases in sediment plumes and turbidity could affect coastal cutthroat trout include sublethal effects (stress, gill damage, and increased susceptibility to disease) and behavioral responses (disruptions to feeding or migration). However, the magnitude and duration of turbidity and sediment plumes generated from geoduck harvest are not expected to be as severe as what is produced during dredging operations and, although they are likely to adversely affect coastal cutthroat trout, they are not expected to rise to the level of affecting survival. Furthermore, coastal cutthroat trout are mobile and because the activity and turbidity will be short-term and localized, most individual coastal cutthroat trout will likely avoid the area.

While it is possible that the action may force coastal cutthroat trout to migrate to waters where there are less foraging opportunities and/or greater risks of predation, we do not expect this action to typically result in significant disruption of normal behavior patterns. We do not expect significant disruption to frequently occur given the amount of available foraging habitat within the marine nearshore and the scope and duration of the stressor. However, over the course of the 50-year Permit, and given the likely decline in the overall quantity of high quality foraging habitat within Puget Sound in the future, there is a likelihood that significant disruption of normal behavior patterns will occasionally occur to individual coastal cutthroat trout.

Disruption of the substrate by the water jets used during geoduck harvest will have a temporary, negative impact on the benthic community. The majority of infauna resides within the top 12 inches of the benthos and is likely to be directly affected by both mobilization of, and temporary changes in, the matrix of sediments in the harvest areas. These small-scale disturbances of the seabed sediments and morphology are likely to result in short-term effects on the benthic community. Filter feeding benthic organisms exposed to increased sediments can suffer from clogged feeding structures, reduced feeding efficiency, and increased stress levels (Hynes 1970). Based on studies of benthic recolonization related to dredging, we expect the benthic community to recolonize and recover quickly after harvest (WNDR 2008). The affected area represents a very small percentage of the marine foraging habitat available to coastal cutthroat trout in the action area, therefore significant disruptions to foraging coastal cutthroat are not anticipated to occur.

We expect that the amount of increased turbidity to be expected from the proposed geoduck harvest will have no significant impacts to forage fish. See the Forage Fish section for a

discussion of impacts to forage fish. Therefore, we will only be considering the direct impacts to individual coastal cutthroat trout due to decreased foraging efficiency and increased predation risk. Coastal cutthroat trout encounters with harvest activities are anticipated to be infrequent, and although the activities may significantly disrupt individual trout's normal behavior patterns associated with feeding and migration, they are not expected to rise to a level that would affect the long-term health of the population as a whole.

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. Human activities and/or land use in the project area would not be altered in the long-term. There are no new developments, industrial uses, or harvest of marine resources (other than associated with the WDNR geoduck harvest) planned for the site that would be caused by the action.

11.3 Effects of the Action – Marbled Murrelet

Direct Effects

Direct effects are the immediate effects of the project on the species or its habitat. Direct effects result from implementation of the proposed Geoduck HCP and include the effects of interrelated and interdependent actions. The direct effects of the proposed project derive from the nature, extent, and duration of geoduck harvest activities in the water and whether murrelets or their prey (forage fish) are present in the area at that time. Positive effects include State governmental protection of areas in and adjacent to the geoduck tracts, thus preventing or minimizing activities which would degrade water quality. Negative effects may occur from vessel and diver (i.e., harvest) activities.

<u>Marbled Murrelet Foraging</u>

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 day and in some cases at night when light conditions are bright enough to see prey (Strachan et al. 1995). Murrelets typically forage in waters less than 550 yd (500 m) (328 to 2,187 yd (300 to 2,000 m)) from shore, and less than 33 yd (30 m) (ranging from less than 1 to greater than 109 yd (less than 1 to greater than 100 m) deep (Burkett 1995).

Murrelets are pursuit divers (Strachan et al. 1995), meaning they use their eyesight to pursue their prey through the water. Murrelets forage at least part of the time near the sea floor, and feed on a variety of prey from different trophic levels (Burkett 1995), though they are mainly a mid-trophic level predator (Becker et al. 2007). Their diets appear to reflect what is most abundant and/or of the highest quality at the time of foraging (Becker et al. 2007; Kuletz 2006). Although this behavior demonstrates an opportunistic feeding strategy, having an abundant and appropriately-sized food source available during nesting and molting may reduce energy demands by requiring less foraging time and, during chick-rearing, fewer trips to and from

inland nests. 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).

The type of prey available will influence nestling survival as well as the number of foraging trips it will take to fledge young (Kuletz 2006). Murrelets typically feed their young fishes, and have not been observed to feed them krill (Becker et al. 2007; Nelson and Peck 1995c). Murrelets feed their young larger fish than they eat themselves (Kuletz 2006; Mahon et al. 1992). Thus when feeding nestlings, their foraging strategy is somewhat specialized. If fewer fishes of the correct size and nutrient value are available, nest productivity and adult condition and/or survival can suffer, and predation risks of both adults and chicks can increase (Anthony and Roby 1997; Kuletz 2006).

Vessel Activities

Geoduck harvest boats and WDNR compliance vessels are on the water during harvest operations. The number of boats participating in the geoduck fishery on one tract at one time ranges between eight and 10. The number of tracts being harvested at one time is usually one, but is sometimes two or three at a time. Future harvest levels could increase, allowing more tracts to be harvested at one time. This would, of course, require additional compliance vessels to be purchased and manned. Noise from boat engines and compressors, spills, and the movement, presence, and anchoring of harvest and compliance boats are all potential sources of impacts to marbled murrelets.

Noise

The noise and general activity from the vessels could potentially disturb murrelets or their prey in the area. Geoduck harvest operations generate noise from two sources: the vessel engines and the pump or compressor engines. Engine noise increases when harvest or compliance boats reposition on the tract, which might happen 1-2 times per day.

On-site measurements found maximum surface noise levels of 50 to 61 A scale decibels (dBA) at a distance of 100 ft (30.5 m). This equates to 111 to 122 dB (re: 1μPa) at 100ft underwater[5]. From a point source in a uniform medium (water or air), sound spreads outward in spherical waves. With spherical spreading, sound levels in air diminish by 6 dBA when the distance is doubled, and by 4.5 dB per doubling distance under water (Teachout 2008). Therefore at 50 ft (15.24 m), noise levels would be 56 to 67 dBA (115.5 to 126.5 dB (re: 1μPa)); at 25 ft (7.6 m)

[5] 50 dBA + 35 = 85 dB (re: 20 micro-Pascals (μPa)) (NEDU p. 4), which is the in-air sound reference pressure based on a human hearing threshold (Teachout 2008, p. 3). 85 db (re:20 μPa) + 26 = 111 dB (re: 1 μPa), which is the reference scale for underwater sound. Decibels (re: 1 μPa) can be roughly compared to dB (root mean square (rms)), which is the sound pressure measurement used when discussing behavioral effects. We do not have the sound data necessary to convert our dB measurements from dBA or dB (re: 1 μPa) into dB (rms): dB (rms) is the root square of the energy (sound) divided by duration, which gives an average of sound readings. Our dBA measurements are likely to be dB (peak) measurements, i.e., the highest reading is recorded. That is a standard method of measurement for in-air sound.

noise levels would be 62 to 73 dBA (120 to 131 dB (re: 1μPa)); and, at 12.5 ft (3.8 m) noise levels would be 68 to 81 dBA (124.5 to 135.5 dB (re: 1μPa)). None of these are loud enough to negatively impact murrelet hearing or behaviors (considered to occur at and above 92 dBA (FWS 2004a:21)) and at and above 150 dB (rms)[4] (Teachout 2008). Sound transmission in shallow water is highly variable and site-specific. Harvesting agreements require harvest vessels to operate at surface noise levels less than 50 dB measured at 200 yd (183 m) from the source. This would allow up to 87 dB when measured at 12.5 ft (7.6 m) from a boat. Birds are unlikely to approach the boats any closer between the time the boats anchor and when they start their compressors. This level is less than the state standard and is well below levels expected to measureable effect marbled murrelets.

Spills

Vessels pose a risk of fuel spills or spills of other hazardous materials that could damage habitat, injure, or kill individual murrelets or their prey. These risks are reduced through a number of measures required by WDNR and include compliance with all Federal, State and local laws and regulations concerning the use and disposal of hazardous, toxic, or harmful substances; WDNR right to enter and inspect any harvest vessel; and the requirement of any harvest vessel in danger of capsizing, or with obvious leaks of toxic or hazardous substances, to return to the docks for repairs. In the past 10 years Todd Palzer, WDNR Shellfish Operations Manager, has received no notice or documentation of any oil or fuel spills occurring related to geoduck harvest, and he is not aware of any prior to that time (T. Palzer, pers. comm. 2008). However, given the 50-year term of the action, we have determined there is a likelihood of a single oil or fuel spill event originating from an event like a boat collision, sinking of vessel from foul weather, or equipment failure. Given the size of the vessels involved, we expect such a spill event to be of relatively small magnitude (i.e., $\leq$ 500 gallons). We anticipate direct exposure of marbled murrelets to such a spill event, regardless of its small size, and that a marbled murrelet would be injured or killed from the oiling of its feathers. However, we do not anticipate indirect effects via prey resources to result in the significant disruption of normal foraging behaviors of marbled murrelets because prey resources are abundant and widely distributed.

Presence, Movement, and Anchoring of Harvest and Compliance Boats

The presence of boats on the water in an area used by murrelets is likely to cause them to avoid at least the area immediately around the boats, and can even cause murrelets to avoid key foraging areas (Agness et al. 2008; Kuletz 1996; Piatt et al. 2007). If a boat were stationary and quiet, chances are that the murrelet would eventually paddle or float close to the boat, but when a boat moves or is repositioned, murrelets would move away. However, all harvest boats sit with idling engines most of the day, with their compressors operating while divers are harvesting (see *Noise* discussion, above). Therefore, we would not anticipate murrelets to return to these areas until harvest operations have concluded for the day.

In a study of the impact of recreational boat traffic on murrelets, it was suggested that birds are less committed to foraging in areas with high boat densities, i.e., boat densities greater than 0.024 boats per ac (8 boats/km^2) (Bellefleur et al. *In Press* 2007). For comparison, the proposed geoduck harvesting will have a density of 1.47 to 4.81 boats per ac (363.3 to 1,188.6 boats/km$^{2)}$,

a much greater density. Therefore we would predict that merely the presence of that density of boats on a tract, regardless of any harvest activities, would cause murrelets to tend to avoid these areas for foraging and could cause murrelets to temporarily avoid key foraging areas.

Based on an average density of 0.0081 birds/ac/day (2 birds/km$^{2/}$day) combined with an estimated maximum of 4.56 ac (0.018 km^2) tract area harvested each day, gives us approximately 0.036 birds present (exposed) on all tracts each day, or a 3.6 percent probability each day that a bird would be present (for 3 tracts, that equals a 1.2 percent probability of a bird being present on each tract).

Most of the research which has been conducted thus far has focused on how boat movement affects seabirds like murrelets. Such movement seems to be what that causes murrelets and other alcids to either dive or fly away. Bellefleur et al. (*In Press* 2007) found that most murrelets reacted within 131 ft (40 m) of the boat, more juveniles flushed than adults, and that when boats approached at speeds greater than 18 miles per hour (mph) (29 kilometers per hour (kph) or 16 knots), birds flushed at farther distances. More birds dove (73 percent) than flew away (26 percent), but 80 percent of the birds that flew (i.e., 21 percent of all birds), left the feeding area altogether, especially if the boats were approaching faster than 12 mph (19 kph or 10 knots). So we expect that 21 percent of the time, birds present on a tract may leave the foraging area when boats approach. Multiplying probabilities (probability of presence by probability of leaving the tracts) gives us a 0.76 percent chance that a bird would leave the tract areas.

In a breeding season study of the closely-related Kittlitz's murrelet (*Brachyramphus brevirostris*), Agness et al. (2008) found that Kittlitz's murrelets moved away from boats initially, but returned within a day once the area was clear. Vessel activity didn't affect group size (Agness et al. 2008), which is important since murrelets use a cooperative foraging strategy, often foraging in pairs during the breeding season (Mahon et al. 1992; Speckman et al. 2003; Strachan et al. 1995). However, there was a 3-fold increase in the number of birds diving on high-boat-traffic days, and a 30-fold increase in flying effort on those days (Agness et al. 2008). We are most concerned about impacts to breeding birds, since they are feeding both themselves and another bird (their chick), and breeding birds are searching for larger fish for their young than for themselves (Kuletz 2006; Mahon et al. 1992).

There are 117 days of overlap between the breeding season (April 1 to September 15) and geoduck harvest activities. There are approximately 250 days per year that geoduck harvest is permitted, thus approximately 47 percent of that time (117/250 days/year) breeding birds will potentially be affected (i.e. flushing, diving) by fast-moving harvest boats. If all boats were to approach foraging murrelets under low speeds, this risk would be considered immeasurable, but the HCP does not require reduced boat speeds. The risk increases in areas of high summer murrelet densities, such as around the San Juan Islands, the Strait of Juan de Fuca west of Dungeness Spit, and northern Hood Canal from approximately the Duckabush River to Marrowstone Island. Currently, there are few surveyed geoduck tracts in the Straits area mentioned above, or in the San Juan Islands, where murrelet densities are recorded to be the highest (PSAMP winter density map, 1993-2005; NWFP Marbled Murrelet Effectiveness Monitoring, summer densities map by PSU, 2000-2007; WDFW 2008). Geoduck harvest could increase in these areas over the term of the HCP.

Flying is energetically expensive for alcids, due to their short wings and heavy bodies (Pennycuick 1987). Nesting murrelets are already under energetic stress due to the requirements of egg-laying, nest attendance, foraging for themselves and a chick, and flying inland to nests, sometimes up to 50 or more mi (80.5 km) one way. Thus any action that causes a breeding bird to fly could increase the energetic load of these birds.

Agness et al. (2008) and others (Speckman et al. 2004) also found that a small portion[6] of fish-holding murrelets (i.e., those who are feeding chicks) dove and/or swallowed the fish they were holding at the approach of fast-moving (greater than 10 mph (16 kph or 9 knots)) or close-approaching (16 to 131 ft (5 to 40 m)) boats. Fish-holding birds were not seen to dive in the absence of boats (Agness et al. 2008). This would result in the need to catch another fish to feed their chick, or chicks going hungry. Boats are only approaching at the start and end of the harvest day, and we are mainly concerned only with breeding birds (April 1 to September 15; this equals about 117 harvest days per year, barring bad weather). Since murrelets' first feeding flight of the day typically occurs prior to sunrise, boats approaching in the morning are unlikely to encounter any fish-holding birds. Therefore, we are only evaluating mid-day feeding trips. Birds returning to their foraging areas would be expected to avoid the area around the (now-stationary) boats as they forage. Thus, it is extremely unlikely that an individual murrelet would dive and/or swallow their prey as a result of boat activity. Furthermore, the biological consequence of such an event, should it occur, is expected to be immeasurable.

Casting and drawing anchor would likely cause any nearby murrelets to move at least a short distance away at those times, simply due to the disturbance of the water. These effects would be lost in the relatively larger effects of boat noise and movement (pre- and post-anchoring).

[6] This study was conducted daily from May through August for 2 years in a row. Murrelets were encountered daily, but only on 8 occasions did the authors witness fish-holding murrelets swallowing fish as the boat approached. Most others paddled away or dove and surfaced nearby. The boats used, however, were small in size (13 to 16 ft (4 to 5 m)) and usually moved slowly from place to place (less than 5 mph (8 kph or 4 knots)) (Speckman et al. 2004, pp. 32-33).

Effects of Geoduck Harvest Activities

Increased Turbidity

During geoduck harvest the divers use a water jet to loosen the material around the geoduck. As the geoducks are harvested, holes are created by the removal of the clam, displacement of sediments, and by suspension of fine particles. Thousands of geoducks are harvested from each tract and an estimate of 10,000 holes per ac (3.3 million holes per km^2) was calculated based on geoduck landing records as representative of the number of holes dug per acre during harvest (WDFW 1985*)*. In reality, geoducks are commonly concentrated in patches, and the actual area where harvest occurs is primarily in these patches.

Effects of geoduck harvest on water quality will likely result from suspension of bottom sediments into the water column. Material is suspended by the action of the water jet, harvest divers walking or swimming near the bottom, and the dragging of water hoses and bags of geoducks. The time the particles remain in the water column depends on their size (small particles remain suspended longer than larger particles), the amount of mixing and lifting, and the water column speed (influenced by tide and tract location/bathymetry).

We expect that the amount of increased turbidity from the proposed geoduck harvest will have no significant impacts to forage fish. See the Forage Fish section for a discussion of impacts to forage fish. Therefore, we will only be discussing the direct impacts to individual murrelets due to decreased foraging efficiency and increased predation risk.

Decreased Foraging Efficiency, Increased Predation Risk

There are 19 herring stocks in Washington (WDFW 2004). The spawning and/or prespawner holding areas of 11 stocks[7] largely overlap currently-surveyed geoduck tracts (WDFW 2008). Small portions of four other stocks[8] overlap current geoduck tracts. Four other stocks[9] do not overlap current geoduck tracts. Using herring spawning and prespawner holding areas as a surrogate for preferred murrelet foraging areas, there are several places where geoduck harvest areas will overlap murrelet foraging areas. However, there are very few currently surveyed geoduck tracts that overlap areas where the densities are recorded to be the highest (Falxa et al. 2008; Nysewander et al, PSAMP winter density map, 1993-2005; WDFW 2008).

All life stages of adult and juvenile murrelets may be exposed to geoduck harvest activities. The number of murrelets that may be exposed depends on location and time of year. Assuming that murrelets would avoid only the area occupied by the boats, an estimated maximum of 4.56 ac (0.018 km^2) tract area would be avoided each day (all tracts combined). Based on densities listed in Tables 9.3.1, 9.3.2 and 9.3.3, an average 0.036 bird would be present on all tracts each day and thus avoiding the boats. Avoidance would potentially occur throughout the year, 5 days a week, 8 hours a day (not including State holidays and inclement weather days), on up to three

[7] Squaxin Pass, Wollochet Bay, Quartermaster Harbor, Port Orchard/Madison, South Hood Canal, Quilcene Bay, Port Gamble, Kilisut Harbor, Holmes Harbor, Discovery Bay, and Dungeness/Sequim.
[8] Port Susan, Samish/Portage Bay, Interior San Juan Islands, and Northwest San Juan Island.
[9] Skagit Bay, Fidalgo Bay, Semiahmoo Bay, and Cherry Point.

tracts a day. Approximately 115 days per year occur on weekends and/or holidays. So for the remaining 250 days per year, 0.036 bird per day would be present and avoiding the boats. You can also express this as a 3.6 percent chance that birds would be present and avoiding boats on all tracts each day (for three tracts, this means a 1.2 percent chance per tract). This is a very low probability.

Murrelets are mobile and will most likely avoid the harvest area. Harvest activity and the related increases in sediment plumes and turbidity would negatively affect murrelets' ability to forage, since they rely on their eyesight to catch prey. Because prey would not be available in the harvest area (either prey moves away or they can't be seen by murrelets), murrelets would have to move to another foraging location. When the harvest area overlaps a foraging area, this could result in a decreased foraging efficiency.

When murrelets are prevented from accessing forage fish in the areas of geoduck harvest, we anticipate that murrelets will only have to move a short distance to find another foraging location. We base this assumption on the relatively small size of sea floor being harvested on a daily basis versus the size of the herring spawning and prespawner holding areas. For non-breeders the extra energy expense is not likely to adversely impact survival. Non-breeders do not need to find an appropriately-sized fish before dawn (and maybe 2 or more times in addition) each day. They can devote more time and energy to foraging for themselves without negative energetic consequences.

If the overlap between foraging and harvest areas occurs during the nesting or molting season, it could lead to decreased survival rates for both adults and, during the nesting season, the young they're feeding. In addition to the effects of increased energy expenditure[10], murrelets could also be exposed to additional predation as they move from place to place. If the "new" location has fewer foraging opportunities, these risks (decreased survival, increased predation) would increase as murrelets travel farther and farther from their original (and presumed favored) foraging location.

In order to avoid predators, trips to the nest are best conducted under cover of darkness, and ideally so are the trips back to their foraging areas. This helps prevent predators from seeing the adults enter and exit the nest itself. Trips that must be conducted during daylight hours become perilous to the adults and young, by exposing them to the sight of predators. For all breeding murrelets, it may be necessary to fly inland during the day in order to feed a chick, but by requiring an *additional* daytime flight (because they couldn't find an appropriately-sized fish in time to avoid sunrise), they are exposed to an additional amount of predation pressure. However, the presence of fishing vessels is not anticipated to adversely affect early morning foraging activities since the vessels are not allowed on the tracts prior to 8:00 AM daily.

We assume that geoduck harvests at locations other than forage fish concentration areas outside of the breeding season result in insignificant effects to individual murrelets. This is because at

[10] During the nesting season, murrelets are expending "extra" energy laying eggs, attending nests, foraging for their chicks in addition to themselves, and flying long distances to and from inland nests. During the molting season, birds can't fly from foraging area to foraging area, and so they are limited to a smaller-than-normal area in which they can forage.

other times and locations, murrelets are not so closely tied to a particular foraging area, and needing or desiring to frequently move to a new foraging area is normal. We assume molting murrelets will still be able to move to adjacent portions of the foraging area without negative energetic effects due to the short distances involved; the small area of geoduck harvest compared to the size of foraging areas means that murrelets won't have to move far to find food.

Thus the birds we are most concerned about are those rearing chicks. But these birds, too, will only have to move a very short distance to access food. Since we assume forage is not locally limiting, we assume all birds will be able to access forage within a very short distance. In addition, the two most frequent times of day that food is delivered to the nest (prior to dawn and at dusk) occur outside the time that geoduck harvest occurs (8 a.m. to 4:30 p.m.), meaning that there would be no conflict with boats or harvesters at those times. The remaining times that chick-rearing birds may need to feed young throughout the day are assumed to be few (to none) in number for many pairs. It is further assumed that if these birds were to return to their favored foraging areas to forage at mid-day, they would be able to avoid harvest boats and find forage fish at a location nearby. The FWS therefore has determined that the risk of impacts to murrelets due to harvest activities is likely to be very small or immeasurable.

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. Human activities and/or land use in the project area would not be altered in the long-term. There are no new developments, industrial uses, or harvest of marine resources (other than associated with the WDNR geoduck harvest) planned for the site that would be caused by the action.

11.4 Effects of the Action – California Brown Pelican

Direct Effects

Direct effects are the immediate effects of the project on the species or its habitat. Direct effects result from implementation of the proposed Geoduck HCP and include the effects of interrelated and interdependent actions. The direct effects of the proposed project derive from the nature, extent, and duration of geoduck harvest activities in the water and whether brown pelicans or their prey (forage fish) are present in the area at that time. Positive effects include protection of areas in and adjacent to the geoduck tracts, thus preventing or minimizing activities which would degrade water quality. Negative effects may occur from vessel and diver (i.e., harvest) activities.

Vessel Activities

Debris

Discarded materials from boats could enter into the water at anytime. Such objects may include geoduck harvest equipment or garbage. If ingested, this debris could lead to brown pelican sickness or even death. Spear et al. (1995) found a strong negative correlation between the amount of ingested plastics and body condition of some seabirds. Ingested plastics could obstruct passage of food or affect physiology of brown pelicans. Although, the FWS does not consider geoduck harvest boats to be a significant source of plastics and other debris, over the 50-year term of the Permit, it is likely that a brown pelican would ingest discarded material from harvest boats and be injured or killed.

Vessel presence

Presence of the 8 to 10 geoduck harvest boats could lead to brown pelican foraging and behavioral changes in the area of the boats, as well as disturbance and behavioral changes to forage fish (prey). Foraging brown pelicans may be temporarily disturbed by harvest boats causing them to move to another area to forage or avoiding foraging areas while boats are present. Roosting sites and loafing areas are essential habitat for breeding, non-breeding local and migrant brown pelicans. Brown pelicans have wettable plumage, so they must have terrestrial roost sites to dry wet plumage after feeding or swimming (Jaques and Anderson 1987). Roost sites are also important for resting and preening. Brown pelicans are affected by ancillary fishing activities, including the presence of vessels, noise, and lights, near roosting and breeding areas (NPS 2008). Harvest boats that approach roosting brown pelicans may flush or disturb birds on the roost. However, harvest boats are required to stay a minimum of 600 feet (183 m) from the shoreline, minimizing the adverse affects of harvest boats in the vicinity of roosting brown pelicans. Limits on harvest time between the hours of 8:00 AM and 4:30 PM, will avoid disturbance of roost sites during night time when brown pelicans are more susceptible to such disturbance. Based on minimum distances that boats must maintain from the shoreline and limits on the time harvest activities can occur, the FWS does not anticipate that vessel presence will be a significant source of disturbance of foraging or roosting brown pelicans. Disturbance to breeding pelicans is not anticipated as these birds do not breed in Washington State.

We assume that the presence of geoduck harvest boats will have no significant impacts to forage fish. See *Forage Fish* section for a discussion of impacts to forage fish.

Vessel anchorage

Casting and drawing anchors would likely cause any nearby brown pelicans to move at least a short distance away at those times, simply due to the disturbance of the water. These effects would be similar to those discussed in *Vessel Presence*.

Oil or gas leaks/spills

Vessels pose a risk of fuel spills or spills of other hazardous materials that could damage habitat, injure, or kill individual brown pelicans or their prey. These risks are reduced through a number of measures required by WDNR and include compliance with all Federal, State and local laws and regulations concerning the use and disposal of hazardous, toxic, or harmful substances; WDNR right to enter and inspect any harvest vessel; and the requirement of any harvest vessel in danger of capsizing, or with obvious leaks of toxic or hazardous substances, to return to the docks for repairs. In the past 10 years Todd Palzer, WDNR Shellfish Operations Manager, has received no notice or documentation of any oil or fuel spills occurring related to geoduck harvest, and he is not aware of any prior to that time (T. Palzer, pers. comm. 2008). However, given the 50-year term of the action, we have determined there is a likelihood of a single oil or fuel spill event originating from an event like a boat collision, sinking of vessel from foul weather or equipment failure. Given the size of the vessels involved, we expect such a spill event to be of relatively small magnitude (i.e., $\leq$ 500 gallons). We anticipate direct exposure of brown pelicans to such a spill event, regardless of its small size, and that a brown pelican would be injured or killed from the oiling of its feathers. However, we do not anticipate indirect effects via prey resources to result in the significant disruption of normal foraging behaviors of brown pelicans because prey resources are abundant and widely distributed.

Noise

Boat motor, pumps, and compressors

The noise and general activity from the vessels could potentially disturb brown pelicans or cause behavioral changes to forage fish (prey) in the area. Geoduck harvest operations generate noise from two sources: the vessel engines and the pump or compressor engines. Engine noise increases when harvest or compliance boats reposition on the tract, this activity may happen 1-2 times per day. The effects from noise to brown pelicans would be similar to those described in vessels presence.

Vessel Presence.

Noise from harvest activities is not anticipated to significantly alter the behavior of forage fish. See *Forage Fish* section for a more detailed discussion of impacts to forage fish.

Geoduck Harvest Activity

Divers i.e. walking around on bottom

Two geoduck harvesters per boat walking on the bottom could cause disturbance and behavioral changes to brown pelicans in the vicinity of the divers, as well as disturbance and behavioral changes to forage fish. Such actions may result in temporary displacement of brown pelicans and forage fish. If disturbed, brown pelicans would be expected to move short distances to avoid divers. Disturbance to roosting brown pelicans is not anticipated.
See *Forage Fish* section for a more detailed discussion of impacts to forage fish.

Water-jet/burst of water and geoduck siphon

The effects from geoduck siphoning to brown pelicans and forage fish are similar to those described in *Divers i.e. walking around on bottom*.

Plumes of sediment

Plumes of sediment from the geoduck harvest by divers using water jets could lead to brown pelican foraging and behavioral changes in the area of sediment plumes, as well as disturbance and behavioral changes to forage fish. Sediment plumes may obscure prey species from brown pelicans fishing overhead. Sediment plumes may result in temporary displacement of brown pelicans and forage fish. If disturbed, brown pelicans would be expected to move short distances to avoid divers. Disturbance to roosting brown pelicans is not anticipated. See *Forage Fish* section for a more detailed discussion of impacts to forage fish.

Holes in substrate

Divots left in the substrate by geoduck harvest methods will have little effect on brown pelicans, but may temporarily alter forage fish habitat. In a study conducted in 1995 (Watson et al.), divots were observed over a 4-day period. Divots that were 2 to 3 inches in depth immediately following harvest activities and were filled with loose sediments, recovered within 4 day. Divots began to refill with sediment after 1 to 2 hours following digging, but sediment remained uncompacted. Divots, after 4 days, were roughly ½ inches deep (barely visible) and sediments in the divots were fully compacted (WDNR video 2007). See *Forage Fish* section for a more detailed discussion of impacts to forage fish.

Eelgrass

Eelgrass buffers will be a 2-foot vertical or 180-foot horizontal (on very gradual slopes) buffer between geoduck tracts adjacent to eelgrass beds and the deepest occurrence of eelgrass. Areas in and adjacent to eel grass beds will be undisturbed minimizing disturbance to brown pelicans and forage fish in the vicinity of eelgrass beds.

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. Human activities and/or land use in the project area would not be altered in the long-term. There are no new developments, industrial uses, or harvest of marine resources (other than associated with the WDNR geoduck harvest) planned for the site that would be caused by the action.

11.5 Effects of the Action – Bald Eagle

Direct Effects

Direct effects are the immediate effects of the project on the species or its habitat. Direct effects result from implementation of the proposed Geoduck HCP and include the effects of interrelated and interdependent actions. The direct effects of the proposed project derive from the nature, extent, and duration of geoduck harvest activities in the water and whether bald eagles are present in the area at that time. Positive effects include State governmental protection of areas in and adjacent to the geoduck tracts, thus preventing or minimizing activities which would degrade water quality. Negative effects may occur from vessel and diver (i.e., harvest) activities.

Vessel Activities

Debris

FWS does not consider discarded materials from boats to a significant risk to bald eagles. Day et al. (1985) found that birds that feed primarily on crustaceans or cephalopods ingest more plastic debris than birds that feed primarily on fish (EPA 1990). Bald eagles are more likely to ingest plastic materials by feeding on prey containing plastic debris than ingesting plastic debris directly (Day et al. 1985; EPA 1990).

Vessel presence

Presence of the 8 to 10 geoduck harvest boats could alter the foraging, roosting, and nesting behaviors of bald eagles within 400 meters (1,312 feet) and 800 meters (2,624 feet) line-of-sight (of nesting eagles) of active harvest tracts. Harvest vessels are required to remain, at least, 600 feet (approximately 200 meters) away from the shoreline.

Foraging bald eagles are susceptible to disturbance by vessel presence, and the magnitude of the disturbance depends on the proximity of the action to perch trees and foraging sites. Foraging bald eagles on the Columbia River estuary maintained an average distance of 400 meters (1,312 feet) from stationary boats, and they responded to boat presence by reducing feeding time and the number of foraging attempts (McGarigal et al. 1991). However, bald eagles may also shift foraging areas based on boat traffic (McGarigal et al. 1991). Grubb and King (1991) found bald eagles were more often flushed from perches than nests, and were most susceptible to disturbance when foraging. Stalmaster and Kaiser (1998) found that bald eagle feeding on the Skagit River declined exponentially with increases in disturbance events. Therefore, the FWS anticipates individual foraging bald eagles within 400 meters (1,312 feet) of active harvest tracts may be flushed from perches, reduce their foraging efforts, or be forced to shift to other foraging areas.

The presence of geoduck harvest vessels may disturb nesting bald eagles, and the magnitude of this disturbance depends on the proximity of the geoduck harvest tracts to an active bald eagle nest territory. In Washington, nearly all bald eagle nests are located within 1 mile of a lake, river, or marine shoreline, and most are within 450 feet (150 meters) to 1,000 feet (330 meters) of the shore (mean = 635 feet from water) (Stinson et al. 2001). Bald eagles remain near nest sites from January through August, but eggs tend to hatch in April and bald eaglets typically

fledge by mid-July. According to Watson et al. (1995), stationary boats used for the harvest of geoducks are more likely to change behavior of nesting bald eagles when harvest occurs within the core use area where eagles forage and during the most intense daily foraging period. Core use areas (which include the nest tree, key perch trees, and the most frequently used foraging perches) and lengths of shoreline used by bald eagles for territories in Puget Sound are much smaller than in other parts of the state, averaging about 0.73 square miles and 2.36 miles, respectively (Watson and Pierce 1998a). The response of nesting bald eagles to human activity can range from behavioral, such as flushing and reduced nest attendance, to nest failure (Anthony et al. 1995; Fraser et al. 1985; Grubb and King 1991; Grubb et al. 1992; McGarigal et al. 1991; Steidl and Anthony 1996; Watson and Pierce 1998a). Watson and Pierce (1998a) found that vegetative screening and distance were the two most important factors determining the impact of disturbances. Heavy vegetative screening can dramatically reduce bald eagle response to human activity. Human activities that are distant, of short duration, out of sight, few in number, below the nest, and quiet have the least impact (Grubb and King 1991; Watson 2004).

The Bald Eagle Recovery Plan (DOI 1986) recommends distances of 400 meters (1,312 feet) and 800 meters (2,624 feet) line-of-sight distances to avoid disturbance to nesting bald eagles. Based on the most recent GIS data obtained from WDFW, 370 bald eagle sites (mostly nest sites but could include communal roost sites) are located within 0.5 miles (800 meters) of a commercial geoduck harvest tract. Of these, 178 sites are located within 0.25 miles (400 meters) of a bald eagle site. Since geoduck harvest can occur at all times of the year, and harvest vessels are only required to remain approximately 600 feet from the shoreline, disturbance to a small portion of the 370 known bald eagles sites can be expected to occur annually over the term of the permit. Such disturbance could lead to flushing and reduced nest attendance and possibly, nest failure.

Wintering bald eagles typically congregate in large aggregations where, most importantly, food is abundant. Suitable perch sites adjacent to foraging areas and winter roost habitat are also necessary. In Washington, these criteria are typically met where waterfowl and salmon populations are present, as well as in marine areas (Stinson et al. 2001). Wintering bald eagles often roost at communal sites which provide shelter during inclement weather. Bald eagles may roost communally in single trees or large forest stands of uneven ages. Bald eagles may remain at their daytime perches throughout the night, but typically gather at large communal roosts in the evening.

Communal night roosting sites are traditionally used year after year. Roost trees are usually the largest and have the most open structure (Keister and Anthony 1983; Watson and Pierce 1998a). They are often located in areas that provide a more favorable microclimate during inclement weather (Keister et al. 1985; Knight et al. 1983; Watson and Pierce 1998a). Prey sources may be available in the general vicinity, but for roosting, close proximity to food is not as critical as the need for shelter. In Washington, 26 roosts studied by Watson and Pierce (1998a) were all within 1,100 meters (3,680 feet) of foraging areas. However, Stalmaster (1987), in reviewing a variety of studies found that only 40 percent were within 1 kilometer (0.69 mile) of water.

Wintering bald eagles are susceptible to disturbance on their foraging grounds. Individual eagles may be disturbed from roosts sites if they are 400 meters or less from an active geoduck harvest tract. However, disturbance to communal night roosts is not anticipated. These areas are

typically located in areas that provide a more favorable micro climate, are usually located further from water than nests or perches, and eagles only gather at these communal roost sites in the evening. Harvest is restricted to between the hours of 8:00 AM and 4:30 PM.

Vessel anchorage

Casting and drawing anchors may disturb any nearby bald eagle causing them to move away or avoid harvest vessels. These effects would be lost in the relatively larger effects of vessel presence, noise, and movement.

Oil or gas leaks/spills

Vessels pose a risk of fuel spills or spills of other hazardous materials that could damage habitat, injure, or kill individual bald eagles. These risks are reduced through a number of measures required by WDNR and include compliance with all Federal, State and local laws and regulations concerning the use and disposal of hazardous, toxic, or harmful substances; WDNR right to enter and inspect any harvest vessel; and the requirement of any harvest vessel in danger of capsizing, or with obvious leaks of toxic or hazardous substances, to return to the docks for repairs. In the past 10 years Todd Palzer, WDNR Shellfish Operations Manager, has received no notice or documentation of any oil or fuel spills occurring related to geoduck harvest, and he is not aware of any prior to that time (T. Palzer, pers. comm. 2008). However, given the 50-year term of the action, we have determined there is a likelihood of a single oil or fuel spill event originating from an event like a boat collision, sinking of vessel from foul weather or equipment failure. Given the size of the vessels involved, we expect such a spill event to be of relatively small magnitude (i.e., $\leq$ 500 gallons). We anticipate direct exposure of bald eagles to such a spill event, regardless of its small size, and that a bald eagle would be injured or killed from the oiling of its feathers or ingestion of oiled prey.

Noise

Boat motor, pumps, and compressors

Noise generated from 8 to 10 geoduck harvest boats could alter the foraging and nesting behaviors of bald eagles within 800 meters (2,624 feet) of active harvest tracts. Harvesters are required to remain, at least, 600 feet (approximately 200 meters) away from shoreline. The effects from noise are similar to those described in *Vessel Presence*. The FWS anticipates disturbance to a small portion of the 370 known bald eagles sites to occur annually over the term of the permit due to noise. Such disturbance could lead to flushing and reduced nest attendance and possibly, nest failure. Noise can also cause eagles to be flushed from perches, reduce their foraging efforts, or be forced to shift to other foraging areas.

Geoduck Harvest Activity

Water-jet/burst of water and geoduck siphon

Since this activity would occur below the surface of the water, direct effects to bald eagles are not anticipated.

Divers i.e. walking around on bottom

Since this activity would occur below the surface of the water, direct disturbance to bald eagles is not anticipated.

Plumes of sediment

Plumes of sediment from the geoduck harvest by divers are not likely to lead to foraging and behavioral disturbance of bald eagles. In most instance, bald eagles are not likely to be in close proximity (closer that 400 meters (1,312 feet)) of active geoduck harvest tract, and therefore, would not be directly effected by sediment plumes. Effects to bald eagles are anticipated to be discountable.

Holes in substrate

Since this activity would occur below the surface of the water direct disturbance to bald eagles is not anticipated. Effects to bald eagles are anticipated to be discountable.

Eelgrass

Eelgrass buffers will be a 2-foot vertical or 180-foot horizontal (on very gradual slopes) buffer between geoduck tracts adjacent to eelgrass beds and the deepest occurrence of eelgrass. Effects to bald eagles are not anticipated from buffers around eelgrass beds.

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. Human activities and/or land use in the project area would not be altered in the long-term. There are no new developments, industrial uses, or harvest of marine resources (other than associated with the WDNR geoduck harvest) planned for the site that would be caused by the action.

11.6 Effects of the Action – Tufted Puffin

Direct Effects

Direct effects are the immediate effects of the project on the species or its habitat. Direct effects result from implementation of the proposed Geoduck HCP and include the effects of interrelated and interdependent actions. The direct effects of the proposed project derive from the nature, extent, and duration of geoduck harvest activities in the water and whether tufted puffins are present in the area at that time. Positive effects include state governmental protection of areas in and adjacent to the geoduck tracts, thus preventing or minimizing activities which would degrade water quality. Negative effects may occur from vessel and diver (i.e., harvest) activities.

Vessel Activities

Debris

Discarded materials from harvest vessels could enter into marine waters at anytime. Such objects may include geoduck harvest equipment or garbage. Some plastic materials are thought to resemble prey species (squid) that are commonly eaten by adult tufted puffin (Piatt and Kitaysky 2002). If ingested, this debris could lead to tufted puffin sickness or even death. Plastic particles were frequently found in gizzards of 20 percent of 837 tufted puffins examined from subarctic Alaska between 1969 and 1990 (Robards et al. 1995); and 88 percent of 8 birds examined from Central North Pacific in 1990–1991 (Robards et al. 1997). Spear et al. (1995) found a strong negative correlation between the amount of ingested plastics and body condition of seabirds. Plastics could obstruct passage of food or affect physiology of tufted puffins. Although the FWS does not consider geoduck harvest boats to be a significant source of plastics and other debris, over the 50-year term of the Permit, it is likely that a tufted puffin would ingest discarded material from harvest boats and be injured or killed.

Vessel presence

Presence of the 8 to 10 geoduck harvest boats could lead to tufted puffin foraging and behavioral changes in the area of the vessels, as well as disturbance and behavioral changes to forage fish (prey). Disturbance during incubation by researches has been shown to lower breeding success and alter the apparent breeding chronology of a colony (Pierce and Simons 1986). But these researchers were land-based and in close proximity to the colony and nest burrows of individual puffins during the sensitive nesting period. The same study showed tufted puffin nestling development was not adversely affected by periodic visits to collect growth data on nestlings. Timing and proximity to a nesting colony appears to determine whether or not disturbance of tufted puffin nesting colonies would be significant. The presence of 8 to 10 geoduck harvest boats, anchored at least 600 feet (183 m) from the shoreline, is anticipated to have little effect on tufted puffin breeding success and behaviors at the nest, as no land-based activities are needed to conduct the harvest of commercial geoduck sites.

Individual puffins could be temporarily displaced by the presence of geoducks harvest vessels. This disturbance may result in reduced feeding time and reduced foraging attempts by tufted puffins or puffins could be force to move short distances to avoid harvest vessels. Disturbance

to nesting adults foraging in marine waters is most likely to occur at two tracts near Protection Island, where a nesting colony exists. A 600-foot buffer around the island provides some protection, and the closest harvestable geoduck tract is about 1,320 feet (402 m) offshore, with the shoreward harvest boundary for that tract set at -31 feet MLLW. Disturbance to individual tufted puffins may also occur at other locations within the three geoducks management regions where tufted puffins have been observed.

The presence of the 8 to 10 geoduck harvest boats is not likely to lead to disturbance and behavioral changes to forage fish. See *Forage Fish* section for a discussion of impacts to forage fish.

Vessel anchorage

Casting and drawing anchor would likely cause any nearby tufted puffins to move a short distance away at those times, simply due to the disturbance of the water. These effects would be lost in the relatively larger effects of vessel presence, movement, and noise.

The anchorage of the 8 to 10 geoduck harvest boats is not likely to lead to disturbance and behavioral changes to forage fish due the disturbance of the substrate. See *Forage Fish* section for a discussion of impacts to forage fish.

Oil or gas leaks/spills

Vessels pose a risk of fuel spills or spills of other hazardous materials that could damage habitat, injure, or kill individual tufted puffins or their prey. These risks are reduced through a number of measures required by WDNR and include compliance with all Federal, State and local laws and regulations concerning the use and disposal of hazardous, toxic, or harmful substances; WDNR right to enter and inspect any harvest vessel; and the requirement of any harvest vessel in danger of capsizing, or with obvious leaks of toxic or hazardous substances, to return to the docks for repairs. In the past 10 years Todd Palzer, WDNR Shellfish Operations Manager, has received no notice or documentation of any oil or fuel spills occurring related to geoduck harvest, and he is not aware of any prior to that time (T. Palzer, pers. comm. 2008). However, given the 50-year term of the action, we have determined there is a likelihood of a single oil or fuel spill event originating from an even like a boat collision, sinking of vessel from foul weather, or equipment failure. Given the size of the vessels involved, we expect such a spill event to be of relatively small magnitude (i.e., $\leq$ 500 gallons). We anticipate direct exposure of tufted puffins to such a spill event, regardless of its small size, and that a tufted puffin would be injured or killed from the oiling of their feathers. However, we do not anticipate indirect effects via prey resources to result in the significant disruption of normal foraging behaviors of tufted puffins because prey resources are abundant and widely distributed.

Noise

Boat motor, pumps, and compressors

Noise due to motors, pumps, and compressors could lead to tufted puffin foraging and behavioral disturbance in the vicinity of harvest vessels, as well as disturbance and behavioral changes to forage fish. Direct disturbance to nesting sites is not anticipated, but individual foraging puffins near nesting colonies may be disturbed by noise generated from geoduck harvest vessels. Such disturbance could reducing feeding time and foraging attempts or may require tufted puffins to shift to other foraging areas.

See the *Forage Fish* section for a discussion of impacts to forage fish.

Geoduck Harvest Activity

Divers i.e. walking around on bottom

Two geoduck harvesters per boat walking on the bottom could cause disturbance and behavioral changes to foraging tufted puffins in the vicinity of the divers, as well as disturbance and behavioral changes to forage fish. Such actions may result in temporary displacement of tufted puffins and forage fish requiring tufted puffins to shift to other foraging areas. See *Forage Fish* section for a more detailed discussion of impacts to forage fish.

Water-jet/burst of water and geoduck siphon

The effects from geoduck siphoning to tufted puffins and forage fish are similar to those described in *Divers i.e. walking around on bottom*. See *Forage Fish* section for a more detailed discussion of impacts to forage fish.

Plumes of sediment

Plumes of sediment from the geoduck harvest by divers using water jets could lead to tufted puffin foraging and behavioral changes in the area of the plume, as well as disturbance and behavioral changes to forage fish (prey). Sediment plumes and turbidity would negatively affect tufted puffins' ability to forage, since they rely on their eyesight to catch prey. Because prey would not be available in the harvest area (either prey moves away or they cannot be seen by puffins), tufted puffins would likely have to move to other foraging locations. When geoduck harvest areas overlaps with tufted puffin foraging areas, decreased foraging efficiency by tufted puffin would be anticipated.

See *Forage Fish* section for a more detailed discussion of impacts to forage fish.

Holes in substrate

Divots left in the substrate by geoduck harvest methods will have little effect on tufted puffins, but may temporarily alter forage fish habitat. In a study conducted in 1995, (Watson et al.), divots were observed over a 4-day period. Divots that were 2 to 3 inches in depth immediately following harvest activities and were filled with loose sediments, recovered within 4 days. Divots began to refill with sediment after 1 to 2 hours following digging, but sediment remained uncompacted. Divots, after 4 days, were roughly ½ inches deep (barely visible) and sediments in the divots were fully compacted (WDNR video 2007). See *Forage Fish* section for a more detailed discussion of impacts to forage fish.

Eelgrass

Activity near eelgrass beds could lead to tufted puffin foraging and behavioral disturbance, as well as disturbance and behavioral changes to forage fish. Such disturbance could reducing feeding time and foraging attempts or may require tufted puffins to shift to other foraging locations. Eelgrass buffers required in the Geoduck HCP will be a 2-foot vertical or 180-foot horizontal (on very gradual slopes) buffer between geoduck tracts adjacent to eelgrass beds and the deepest occurrence of eelgrass. Areas in and adjacent to eelgrass beds will be undisturbed minimizing disturbance to tufted puffins and forage fish in the vicinity of eelgrass beds.

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. Human activities and/or land use in the project area would not be altered in the long-term. There are no new developments, industrial uses, or harvest of marine resources (other than associated with the WDNR geoduck harvest) planned for the site that would be caused by the action.

12.0 INTERRELATED AND INTERDEPENDENT ACTIONS

Interrelated and interdependent actions are actions that would not occur but for the proposed action under consultation. An interrelated action is an action that is part of the proposed action and depends on the proposed action for its justification. An interdependent action is an action that has no independent utility apart from the proposed action. There are no interrelated or interdependent actions associated with the proposed project.

13.0 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 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.

13.1 Cumulative Effects – Bull Trout

Cumulative effects are those effects of future State, Tribal, local or private actions, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action considered in this Opinion.

There are ongoing activities within and adjacent to the action area, including boat traffic, and, in some cases, adjacent Tribal geoduck harvest that will continue and may increase in the future. Urban development will increase in the future and will result in increased stormwater and wastewater discharges and degraded water quality. Bull trout and their prey species are likely to be impacted by these activities. Their exposure is most likely to occur during the late fall, winter, and early spring when rain events are most likely to occur. The response to these exposures will depend on the level of contaminants discharged, which is dependent upon many factors (e.g., existence of stormwater BMPs, maintenance of the stormwater BMPs, time between rain events). We do expect that significant dilution will occur when stormwater and waste water is discharged into the Puget Sound.

Climate Change

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

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (Hari et al. 2006; ISAB 2007; Rieman et al. 2007). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (WWF 2003). The range of many species has shifted poleward and elevationally upward. For cold-water associated salmonids in mountainous regions, where their upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in range, which in turn can lead to a population decline (Hari et al. 2006).

In the Pacific Northwest, most climate change predictive models project warmer air temperatures, increases in winter precipitation, and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas. Higher air temperatures are also likely to increase water temperatures (ISAB 2007). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers (WDOE 2008).

Climate change has the potential to profoundly alter the aquatic ecosystems upon which the bull trout depends via alterations in water yield, peak flows, and water temperatures in streams and

large waterbodies, and an increase in the frequency and magnitude of catastrophic wildfires in adjacent terrestrial habitats (Bisson et al. 2003).

All life stages of the bull trout rely on cold water. Increasing air temperatures are likely to impact the availability of suitable cold water habitat. For example, ground water temperature is generally correlated with mean annual air temperature, and has been shown to strongly influence the distribution of other chars. Ground water temperature is linked to bull trout selection of spawning sites, and has been shown to influence the survival of embryos and early juvenile rearing of bull trout (Rieman et al. 2007). Increases in air temperature are likely to be reflected in increases in both surface and groundwater temperatures.

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

Migratory bull trout can be found in lakes, large rivers and marine waters. Probable physical effects of climate change to rivers that are relevant to migratory bull trout include increased competition and predation due shift in distribution of both predator and prey species and reduced freshwater survival because of increased stream temperatures, reduced summer flows, and increased winter flows resulting in scouring and sedimentation (Irvine 2004).
Physical effects of climate change on lakes are likely to impact migratory adfluvial bull trout that seasonally rely upon lakes for their greater availability of prey and access to tributaries. Climate-warming impacts to lakes will likely lead to longer periods of thermal stratification, and coldwater fish such as adfluvial bull trout will be restricted to these bottom layers for greater periods of time. Deeper thermoclines resulting from climate change may further reduce the area of suitable temperatures in the bottom layers and intensify competition for food (WWF 2003).

There are a number of climate change driven factors that are likely to affect the water quality and productivity of nearshore marine habitat used by anadromous bull trout. Future global sea-level rise is likely to accelerate as a result of global warming and this may lead to exacerbating problems with fecal coliform contamination resulting from increased septic system leakage. Sea-level rise will also affect the photic zone, which is a key component for productive eelgrass beds. Eelgrass beds provide forage opportunities for bull trout and important habitat for their prey species such as Pacific herring. Increased winter rains as a result of climate change are predicted for the Pacific Northwest, which will likely lead to increased stormwater runoff. Changes in timing and magnitude of freshwater input could affect the salinity, DO levels, circulation, stratification and mixing of Puget Sound and Hood Canal, which in turn could alter the health of marine organisms that support productivity in these waters. And, increases in water temperature, both in the marine nearshore waters and in the lower rivers, through which bull trout migrate on

the way to spawning habitat, could result in fewer spawners or spawners in poor condition arriving at the spawning grounds. The degree to which these changes affect marine nearshore areas will vary with specific characteristics of the area, its location in the Sound, the Straits, or Hood Canal, its freshwater sources, and the dynamics of the ecosystem in that particular area (Snover et al. 2005).

Bull trout require very cold water for spawning and incubation, and suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change are likely to cause shifts in timing, magnitude and distribution of peak flows, and these changes are predicted to be most pronounced in high elevation stream basins (Battin et al. 2007). The increased magnitude of winter peak flows in high elevation areas is likely to impact the location, timing, and success of spawning and incubation for the bull trout and Pacific salmon species. Although lower elevation river reaches are not expected to experience as severe an impact from alterations in stream hydrology, they are unlikely to provide suitably cold temperatures for bull trout spawning, incubation and juvenile rearing.

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

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

13.2 Cumulative Effects – Coastal Cutthroat Trout

There are ongoing activities within and adjacent to the action area, including boat traffic, and, in some cases, adjacent Tribal geoduck harvest that will continue and may increase in the future. Urban development will increase in the future and will result in increased stormwater and wastewater discharges and degraded water quality. Coastal cutthroat trout and their prey species are likely to be impacted by these activities. Their exposure is most likely to occur during the late fall, winter, and early spring when rain events are most likely to occur. The response to these exposures will depend on the level of contaminants discharged, which is dependent upon many factors (e.g., existence of stormwater BMPs, maintenance of the stormwater BMPs, time between rain events). The response to these exposures will depend on the level of contaminants discharged, which is dependent upon many factors (e.g., existence of stormwater BMPs, maintenance of the stormwater BMPs, time between rain events). We do expect that significant dilution will occur when stormwater and waste water is discharged into the Puget Sound.

Cumulative effects are also likely to be similar for coastal cutthroat trout and bull trout (See Cumulative Effects - Bull Trout). Both will continue to be impacted by impacts associated with urban development, especially stormwater and wastewater runoff and changes to the hydrograph in urban streams. Climate change is likely to impact water quality and productivity of marine and freshwater environments and reduce cutthroat trout forage base, and spawning, rearing and migratory habitat.

13.3 Cumulative Effects – Marbled Murrelets

Cumulative effects are those effects of future State, Tribal, local or private actions not involving Federal activities, which are reasonably certain to occur in the foreseeable future within the action area of the proposed Geoduck HCP.

There are ongoing activities within and adjacent to the action area, including boat traffic, and, in some cases, adjacent Tribal geoduck harvest that will continue and may increase in the future.

Urban development will increase in the future and will result in increased stormwater and waste discharges and degraded water quality. Murrelets and their prey species are likely to be impacted by these activities. Their exposure to degraded water quality is most likely to occur during the late fall, winter, and early spring when rain events usually occur. The response to these exposures will depend on the level of contaminants discharged, which is dependent upon many factors (e.g., existence of stormwater BMPs, maintenance of the stormwater BMPs, time between rain events). We do expect that significant dilution will occur when stormwater and wastewater is discharged into the Puget Sound. The response to these exposures will depend on the level of contaminants discharged, which is dependent upon many factors (e.g., existence of stormwater BMPs, maintenance of the stormwater BMPs, time between rain events).

Climate Change

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

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (Hari et al. 2006; ISAB 2007; Rieman et al. 2007). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (WWF 2003). The range of many species has shifted poleward and/or elevationally upward.

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas, but water temperatures will be higher. Higher air temperatures are also likely to increase water temperatures (ISAB 2007). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers (WDOE 2008). Since murrelet productivity is highest in cool ocean conditions (Becker et al. 2007:277), an overall increase in ocean temperatures could have severe negative effects on murrelet survival and recovery.

Climate change has the potential to profoundly alter the aquatic and terrestrial ecosystems upon which the murrelet depends via alterations in water temperature, and an increase in the frequency and magnitude of catastrophic wildfires (Bisson et al. 2003), which affects amount, distribution, and quality of nesting habitat.

Climate change is likely to affect the frequency and magnitude of fires, especially in warmer, drier areas. Bisson et al. (2003) noted that the forest that naturally occurred in a particular area may or may not be the forest that will be responding to the fire regimes of an altered climate. The future may well be different than the past and extreme fire events may have a dramatic effect on murrelets, especially in the context of continued loss, simplification and fragmentation of aquatic and terrestrial habitats, and the introduction and expansion of exotic aquatic and terrestrial species (Bisson et al. 2003).

There are a number of climate change driving factors that are likely to affect the water quality and productivity of nearshore marine habitat used by foraging murrelets. Future global sea-level rise is likely to accelerate as a result of global warming and this may exacerbate problems with fecal coliform contamination resulting from increased septic system leakage. Increased winter rains as a result of climate change are predicted for the Pacific Northwest, which would likely lead to more stormwater runoff. Changes in timing and magnitude of freshwater input could affect the salinity, DO levels, circulation, stratification and mixing of the Sound and Hood Canal,

which in turn would alter the health of marine organisms that support productivity in these waters. The degree to which these changes affect marine nearshore areas will vary with specific characteristics of the area, its location in the Sound, the Straits, or Hood Canal, its freshwater sources, and the dynamics of the ecosystem in that particular area (Snover et al. 2005).

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007) although the scale of that variation may exceed that of states. There is little doubt that climate change is and will be an important factor affecting both murrelet distribution and abundance in the action area.

13.4 Cumulative Effects – California Brown Pelican

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Threats to brown pelican include these future non-Federal activities in the marine environment:

1. Release of petroleum products/additives created from oil spills.
2. Other marine contaminants released in the marine environment.
3. Discarded material from boats.
4. Lost fishing nets, tackle, lines, etc.
5. Disturbance from recreational, commercial, and research monitoring vessels.
6. Tribal geoducks fishery

To summarize, cumulative effects to brown pelicans from activities in the marine environment (release of petroleum products and chemicals, discarded plastics and gillnets, and disturbance from boat traffic) are anticipated. The extent of these impacts to brown pelican has not been quantified. However, with the human population expected to continue to increase within the Puget Sound basin over the term of the Permit, we anticipate that there will be corresponding increases in the amount of boat traffic, chemical and oil discharges, and oil spills (Puget Sound Regional Council 2004). Although these future non-Federal actions in the marine environment largely represent continuing threats, the significance or extent of these impacts to brown pelican populations in the action area have not been quantified.

<u>Climate Change</u>

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

species and in a wide range of environmental trends (Hari et al. 2006; ISAB 2007; Rieman et al. 2007). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (WWF 2003). The range of many species has shifted poleward and/or elevationally upward.

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas, but water temperatures will be higher. Higher air temperatures are also likely to increase water temperatures (ISAB 2007). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers (WDOE 2008).

There are a number of climate change driving factors that are likely to affect the water quality and productivity of nearshore marine habitat used by foraging brown pelicans. Future global sea-level rise is likely to accelerate as a result of global warming and this may exacerbate problems with fecal coliform contamination resulting from increased septic system leakage. Increased winter rains as a result of climate change are predicted for the Pacific Northwest, which would likely lead to more stormwater runoff. Changes in timing and magnitude of freshwater input could affect the salinity, DO levels, circulation, stratification and mixing of the Sound and Hood Canal, which in turn would alter the health of marine organisms that support productivity in these waters. The degree to which these changes affect marine nearshore areas will vary with specific characteristics of the area, its location in the Sound, the Straits, or Hood Canal, its freshwater sources, and the dynamics of the ecosystem in that particular area (Snover et al. 2005).

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007) although the scale of that variation may exceed that of states. There is little doubt that climate change is and will be an important factor affecting both brown pelican's distribution and abundance in the action area.

13.5 Cumulative Effects – Bald Eagles

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Threats to bald eagles include these future non-Federal activities in the marine environment:

1. Release of petroleum products/additives created from oil spills.
2. Disturbance from recreational, commercial, and research-monitoring vessels.
3. Lost fishing nets, tackle, lines, etc.
4. 4. Disturbance from recreational, commercial, and research monitoring vessels.
5. Tribal geoducks fishery

To summarize, cumulative effects to bald eagles from activities in the marine environment (release of petroleum products and disturbance from boat traffic) are anticipated. The extent of these impacts to bald eagles has not been quantified. However, with the human population expected to continue to increase within the Puget Sound basin over the term of the Permit, we anticipate that there will be corresponding increases in the amount of boat traffic, chemical and oil discharges, and oil spills (Puget Sound Regional Council 2004). Although these future non-Federal actions in the marine environment largely represent continuing threats, the significance or extent of these impacts to bald eagle populations in the action area has not been quantified.

Climate Change

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

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (Hari et al. 2006; ISAB 2007; Rieman et al. 2007). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (WWF 2003). The range of many species has shifted poleward and/or elevationally upward.

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas, but water temperatures will be higher. Higher air temperatures are also likely to increase water temperatures (ISAB 2007). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers (WDOE 2008).

Climate change has the potential to profoundly alter the aquatic and terrestrial ecosystems upon which the bald eagles depends via alterations in water temperature, and an increase in the frequency and magnitude of catastrophic wildfires (Bisson et al. 2003), which affects amount, distribution, and quality of nesting habitat.

Climate change is likely to affect the frequency and magnitude of fires, especially in warmer, drier areas. Bisson et al. (2003) noted that the forest that naturally occurred in a particular area may or may not be the forest that will be responding to the fire regimes of an altered climate. The future may well be different than the past and extreme fire events may have a dramatic effect on bald eagles, especially in the context of continued loss, simplification and fragmentation of aquatic and terrestrial habitats, and the introduction and expansion of exotic aquatic and terrestrial species (Bisson et al. 2003).

There are a number of climate change driving factors that are likely to affect the water quality and productivity of nearshore marine habitat used by foraging bald eagles. Future global sea-level rise is likely to accelerate as a result of global warming and this may exacerbate problems with fecal coliform contamination resulting from increased septic system leakage. Increased winter rains as a result of climate change are predicted for the Pacific Northwest, which would likely lead to more stormwater runoff. Changes in timing and magnitude of freshwater input could affect the salinity, dissolved oxygen levels, circulation, stratification and mixing of the Sound and Hood Canal, which in turn would alter the health of marine organisms that support productivity in these waters. The degree to which these changes affect marine nearshore areas will vary with specific characteristics of the area, its location in the Sound, the Straits, or Hood Canal, its freshwater sources, and the dynamics of the ecosystem in that particular area (Snover et al. 2005).

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007) although the scale of that variation may exceed that of States. There is little doubt that climate change is and will be an important factor affecting both the distribution and abundance of bald eagles in the action area.

13.6 Cumulative Effects – Tufted Puffin

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Threats to tufted puffin include these future non-Federal activities in the marine environment:

1. Release of petroleum products/additives created from oil spills.
2. Other marine contaminants released in the marine environment.
3. Discarded material from boats.
4. Lost fishing nets.
5. Disturbance from recreational boating, and commercial and research monitoring vessels.
6. Possible introduction of non-native invasive species to breeding and nesting grounds.
7. Tribal geoducks fishery.

To summarize, cumulative effects to tufted puffins from activities in the marine environment (release of petroleum products and chemicals, discarded plastics and gillnets, and disturbance from boat traffic) are anticipated. The extent of these impacts to tufted puffin has not been quantified. However, with the human population expected to continue to increase within the Puget Sound basin over the term of the Permit, we anticipate that there will be corresponding increases in the amount of boat traffic, chemical and oil discharges, and oil spills (Puget Sound Regional Council 2004). Although these future non-Federal actions in the marine environment

largely represent continuing threats, the significance or extent of these impacts to tufted puffin populations in the action area has not been quantified.

Climate Change

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

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (Hari et al. 2006; ISAB 2007; Rieman et al. 2007). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (WWF 2003). The range of many species has shifted poleward and/or elevationally upward.

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas, but water temperatures will be higher. Higher air temperatures are also likely to increase water temperatures (ISAB 2007). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers (WDOE 2008). Since tufted puffin productivity is highest in cool ocean conditions (Becker et al. 2007:277), an overall increase in ocean temperatures could have severe negative effects on tufted puffin's survival and recovery.

Climate change has the potential to profoundly alter the aquatic ecosystem upon which the tufted puffins depends via alterations in water temperature and forage fish distribution. There are a number of climate change driving factors that are likely to affect the water quality and productivity of nearshore marine habitat used by foraging tufted puffins. Future global sea-level rise is likely to accelerate as a result of global warming and this may exacerbate problems with fecal coliform contamination resulting from increased septic system leakage. Increased winter rains as a result of climate change are predicted for the Pacific Northwest, which would likely lead to more stormwater runoff. Changes in timing and magnitude of freshwater input could affect the salinity, DO levels, circulation, stratification and mixing of the Sound and Hood Canal, which in turn would alter the health of marine organisms that support productivity in these waters. The degree to which these changes affect marine nearshore areas will vary with specific characteristics of the area, its location in the Sound, the Straits, or Hood Canal, its freshwater sources, and the dynamics of the ecosystem in that particular area (Snover et al. 2005).

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007) although the scale of that variation may exceed that of states.

There is little doubt that climate change is and will be an important factor affecting both tufted puffin's distribution and abundance in the action area.

14.0 CONCLUSION

14.1 Conclusion – Bull Trout

After reviewing the current status of the bull trout, the environmental baseline for the action area, the effects of the proposed Geoduck HCP, and the cumulative effects, it the FWS's Opinion that the Geoduck HCP, as proposed, is not likely to jeopardize the continued existence of the bull trout.

This determination is based on the following rationale:

- Long-term preclusion of bull trout in the action area is not expected. Impacts to bull trout from the proposed project will be short-term (during daylight hours and for the duration of harvest in the targeted tract).

- Although the majority of migratory bull trout with access to marine waters become anadromous, only a small percentage of anadromous individuals are expected in the action area during harvest activities.

- While the potential for harm/harassment is unquantifiable in terms of the number of fish potentially affected, the number of bull trout adversely affected is small and the action area is only a small fraction of the available habitat of the Costal-Puget Sound IRU.

- The fish exposed to the effects of the action are likely to be from 9 of 14 core areas in the Coastal-Puget Sound IRU. Therefore, the effects will be distributed among several core areas. Distribution of these effects to a small number of individuals across nine core areas is not expected to appreciably reduce the distribution, reproduction, and number of bull trout within the coterminous range.

- Disruption of migratory corridors and water quality impacts associated with elevated sediment levels are expected to be localized and short-term, and will not preclude use by bull trout of designated critical habitat throughout the action area.

Bull Trout Critical Habitat

After reviewing the current status of bull trout, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the Geoduck HCP, as proposed, is not likely to adversely modify bull trout critical habitat. It is the Service's biological opinion that the action, as proposed, will not destroy or adversely modify designated bull trout critical habitat. This determination is based on the following:

- Critical habitat was designated in marine waters in the action area to address the FMO needs of bull trout. PCEs include adequate water temperatures, migratory corridors with

no barriers, an abundant food base, and permanent water of sufficient quantity and quality.

- The action area is in critical habitat from two Critical Habitat Units (CHU), the Olympic Peninsula and Puget Sound CHUs. These CHUs provide for subadult and adult migration, forage and refugia. These units are important to maintaining the overall distribution and genetic diversity of bull trout.

- The proposed action will have adverse effects to critical habitat, specifically to PCE vi (migratory corridors with minimal physical, biological, or water quality impediments) and PCE viii (permanent water of sufficient quantity and quality).

- Adverse effects to PCE vi are also expected to be localized and dispersed throughout the critical habitat units. Harvest activities on a particular tract do not occur year-round as harvest is intentionally rotated between tracts and regions.

- Adverse effects to PCE viii associated with sediment are expected to be localized and of short duration, and dispersed throughout the critical habitat units. PCE viii in affected areas will continue to support bull trout.

- The direct and indirect effects of the proposed action (permanent and temporary) will not preclude bull trout from foraging, migrating or overwintering within the action area. Effects to habitat connectivity will be insignificant at the scale of the CHU area.

- Within the action area, designated bull trout critical habitat will remain functional. The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, tribal, local, and private actions will not prevent the PCEs of critical habitat from being functionally maintained at the scale of the action area. Critical habitat within the action area will continue to serve the intended conservation role for the species at the scale of the core area, interim recovery unit, and coterminous range.

14.2 Conclusion – Coastal Cutthroat Trout

After reviewing the current status of the coastal cutthroat trout , the environmental baseline for the action area, the effects of the proposed WDNR Geoduck HCP, and the cumulative effects, it is the FWS's Opinion that the WDNR Geoduck HCP, as proposed, is not likely to jeopardize the continued existence of the coastal cutthroat trout.

This determination is based on the following rationale:

- Effects of geoduck harvest to coastal cutthroat trout are likely to be similar to those affecting bull trout. The most prevalent effect is likely to result from increased sediment and turbidity levels in areas where geoduck harvest is occurring, and given the likely decline in the overall quantity of high quality foraging habitat within Puget Sound over

the course of the 50-year Permit, there is a likelihood that significant disruption of normal behavior patterns will occasionally occur to individual coastal cutthroat trout. However, the magnitude and duration of turbidity and sediment plumes from geoduck harvest are not anticipated to rise to the level of affecting numbers, distribution or survival of coastal cutthroat trout. Furthermore, coastal cutthroat trout are mobile and because the activity and turbidity will be short-term and localized, individual coastal cutthroat trout will most likely avoid the area. This may cause coastal cutthroat trout to migrate to waters where there are less foraging opportunities or greater risks of predation.

- Although information is limited, it does not appear that coastal cutthroat trout occupy marine waters at depths as great as bull trout (Goetz et al. 2004b; USGS *in litt.* 2008). Because coastal cutthroat trout are higher in the water column they may not experience as great an impact from increased sediment and turbidity as bull trout in the harvest area.

- Long-term preclusion of coastal cutthroat trout in the action area is not expected. Impacts to coastal cutthroat trout from the proposed project will be short-term (during daylight hours and for the duration of harvest in the target tract).

- While the potential for harm/harassment is unquantifiable in terms of the number of fish potentially affected, the number of coastal cutthroat trout adversely affected is small and the action area is only a small fraction of the available habitat of the coastal cutthroat trout in Puget Sound, Hood Canal and the Strait of Juan de Fuca.

14.3 Conclusion – Marbled Murrelet

After reviewing the current status of the marbled murrelet , the environmental baseline for the action area, the effects of the proposed WDNR Geoduck HCP, and the cumulative effects, it is the FWS's Opinion that the WDNR Geoduck HCP, as proposed, is not likely to jeopardize the continued existence of the marbled murrelet.

This determination is based on the following rationale:

- Murrelets from Conservation Zone 1 are present in the action area. The murrelet population in Conservation Zone 1 is relatively large, with an estimated population of 7,000 (4,100 – 10,400). However, the poor breeding success inferred from juvenile ratios determined through at-sea monitoring in Conservation Zone 1 and an adult survival estimate of 0.83 to 0.93, led investigators to conclude the murrelet population trend is negative (McShane et al. 2005; Cam et al. 2003; Ralph et al. 1995).

- Areas affected by noise and sediment will continue to support foraging by marbled murrelets. We anticipate one murrelet will be killed as a result of an oil or fuel spill event. We do not anticipate this single mortality over the course of the 50-year permit term will result in a measurable reduction in the likelihood of persistence of murrelets within Conservation Zone 1or the species' listed range. Therefore, anticipated direct and indirect effects of the action, combined with the effects of interrelated/interdependent actions and cumulative effects, will not appreciably reduce the likelihood of both survival

and recovery of the marbled murrelet.

14.4 Conclusion – California Brown Pelican

After reviewing the current status of the brown pelican, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the FWS's Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the brown pelican.
No critical habitat has been designated for this species in the action area; therefore, none will be affected.

This determination is based on the following rationale:

- The most recent population estimate of the brown pelican subspecies that ranges from California to Mexico along the Pacific Coast is approximately 71,200 nesting pairs, which equates to 142,400 breeding birds. (Henny and Anderson 2007). These birds nest in four distinct geographic areas along the Pacific Coast (DOI 2008). From these estimates in 2006, Henny and Anderson (2007) concluded there is a large and healthy total breeding population for California and the Pacific Coast of Mexico (DOI 2008).

- No breeding populations of brown pelicans occur in Washington State; therefore, none will be affected by the proposed action. The largest concentration of non-breeding brown pelicans in Washington State are found at mouth of the Columbia River, in Willapa Bay, and in Grays Harbor and will be unaffected by the proposed action. Smaller numbers of non-breeding brown pelicans occur in Puget Sound and in areas where geoduck harvest will occur.

- We have determined there is a likelihood of a single oil or fuel spill event over the 50-year term of the action. We anticipate direct exposure of brown pelicans to such a spill event, regardless of its small size, and that brown pelicans would be injured or killed from the oiling of their feathers. We do not anticipate this level of mortality over the course of the 50-year permit term will result in a measurable reduction in the likelihood of persistence of brown pelicans within the action area or the species' listed range.

- We do not consider geoduck harvest boats to be a significant source of plastics and other debris, however, over the 50-year term of the Permit, it is likely that a single brown pelican may ingest discarded material from harvest boats and be injured or killed. We do not anticipate this level of mortality over the course of the 50-year permit term will result in a measurable reduction in the likelihood of persistence of brown pelicans within the action area or the species' listed range.

14.5 Conclusion – Bald Eagle

After reviewing the current status of the bald eagle, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the FWS's Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the bald eagle. No critical habitat has been designated for this species; therefore, none will be affected.

This determination is based on the following rationale:

- Since 1989 the bald eagle nesting population has increased at an average rate of approximately 8 percent per year (USDI 1999). Bald eagle recovery goals have generally been met or exceeded throughout its range (USDI 1999). Of the seven states covered in the Pacific Recovery Area, Washington State supports the largest breeding and wintering populations (FWS 1986). In 2001, 684 nest territories were occupied in Washington (WDFW *in litt.* 2003). Most nesting territories in Washington are located on the San Juan Islands, along the coastline of the Olympic Peninsula, along the Strait of Juan de Fuca, Puget Sound, Hood Canal, and the Columbia River. Wintering concentration areas in Washington are along salmon spawning streams and waterfowl wintering areas (Stinson et al. 2001). In the Pacific Recovery Area population delisting goals have been met since 1995, the productivity objective of an average of 1.0 young per occupied breeding area has been met since 1990, and the average success rate for occupied breeding areas of 65 percent has been exceeded since 1994 (USDI 1999).

- We anticipate direct exposure of bald eagles to an oil or fuel spill event, regardless of its small size, and that a single bald eagle would be injured or killed from the oiling of their feathers or ingestion of oiled prey. We do not anticipate this level of mortality over the course of the 50-year permit term will result in a measurable reduction in the likelihood of persistence of bald eagles within the action area or the species' range.

14.6 Conclusion – Tufted Puffin

After reviewing the current status of the tufted puffin, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the FWS's Opinion that the action, as proposed, is not likely to jeopardize the continued existence of the tufted puffin.

No critical habitat has been designated for this species; therefore, none will be affected.

This determination is based on the following rationale:

- The largest concentration of tufted puffins (Conservation Zone 2) remaining in Washington marine waters will be unaffected by the proposed action. Smaller populations of breeding tufted puffins may occur in and around areas where geoduck harvest will occur, although several of the known breeding sites are not adjacent to geoduck harvest tracts. In addition, a large majority of the wintering tufted puffin population occurs in the Pacific Ocean. Few birds winter in Puget Sound, the San Juan

Islands, and the Strait of Juan de Fuca where geoduck harvest occurs or will occur over the permit term.

- The total world population estimate is 2,971,260 birds taken from Piatt and Kitaysky (2002). Eighty-two percent (2,441,120 numbers of individuals) of the population estimate is in North America. Piatt and Kitaysky (2002) also includes the statistics of the North American tufted population mentioning a range of population percentages including population/percentage of individuals in California (0 - 0.01 percent), Oregon (0.2 percent), Washington (0.8 – 0.9 percent), and British Columbia (2.6 – 3.1 percent). The remainder of the population is lumped into Alaska, with the largest concentrations of individuals in the Gulf of Alaska (32.1 - 36 percent) and in the Aleutian Islands (42.8 - 45 percent), and tufted puffin populations in the Bering (4 - 4.6 percent) and Chukchi (0 - <0.01 percent) seas.

- The FWS does not consider geoduck harvest boats to be a significant source of plastics and other debris; however, over the 50-year term of the Permit, it is likely that individual tufted puffins may ingest discarded material from harvest boats and be injured or killed. We do not anticipate this level of mortality over the course of the 50-year permit term will result in a measurable reduction in the likelihood of persistence of tufted puffins within the action area or the species' range.

- Given the 50-year term of the action, we have determined there is a likelihood of a single oil or fuel spill event. Given the size of the vessels involved, we expect such a spill event to be of relatively small magnitude (i.e., ≤ 500 gallons). We anticipate direct exposure of tufted puffins to such a spill event, regardless of its small size, and that a single tufted puffin would be injured or killed from the oiling of their feathers. We do not anticipate this level of mortality over the course of the 50-year permit term will result in a measurable reduction in the likelihood of persistence of tufted puffins within the action area or the species' range.

15.0 INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. *Harm* is defined by the FWS as 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* is defined by the FWS as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part

of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The Low Effect Commercial Geoduck Fishery Habitat Conservation Plan and its associated documents clearly identify anticipated impacts to affected species likely to result from the proposed taking and the measures that are necessary and appropriate to minimize those impacts. All conservation measures described in the proposed Geoduck HCP, together with the terms and conditions described in any associated Implementing Agreement and any section 10(a)(1)(B) permit or permits issued with respect to the proposed Geoduck HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this Incidental Take Statement pursuant to 50CFR 402.14(i). Such terms and conditions are non-discretionary and must be undertaken for the exceptions under the section 10(a)(1)(B) and section 7(o)(2) of the Act to apply. If the Permittee fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The amount or extent of incidental take anticipated under the proposed Geoduck HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the Geoduck HCP and its accompanying section 10(a)(1)(B) permit.

The FWS 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 (16 U.S.C. 703-712) or the Bald and Golden Eagle Protection Act, as amended (16 U.S.C. 668-668d), if such take is in compliance with the terms and conditions (including the amount and/or numbers) specified herein.

15.1 Bull Trout

Form and Amount or Extent of Take

Based on the biological effects described above under the “Effects of the Action” section, implementation of the proposed action is likely to cause the incidental take of the bull trout in the form of harass and potentially harm.

Quantifying and detecting that take in terms of individual bull trout is not possible for specific locations because of the variable distribution and abundance of bull trout in the action area. The Service anticipates incidental take of individual bull trout will be difficult to detect or quantify for the following reasons: (1) the low likelihood of finding dead or injured subadults or adults, (2) delayed mortality, (3) the rapid rate of fish decomposition, and (4) the high probability of scavenging by predators. The FWS anticipates that the following form of take will occur as a result of the activities associated with the project:

> Take of bull trout in the form of harassment and potentially harm will occur through the disruption of normal migrating and foraging behaviors associated with direct impacts resulting from elevated sediment levels. Elevated sediment levels are expected to result from diver activities associated with geoduck harvest. The life-history forms expected to be harassed by these activities are anadromous subadult and adult bull trout. Although bull trout within the Action Area during geoduck harvest may be from one or multiple core areas, it is not possible to determine from which

core area a particular fish originated. The take exempted by this incidental take statement is for:

> Those bull trout that are significantly disrupted during harvest operations associated with the total acreage of surveyed geoduck tracts, which is approximately of 40,800 acres over 6 Management Regions and 10,200 acres per one management region for the 50-year permit period. The total acreage of surveyed tracts fluctuates because newly discovered beds are added, or the status of an existing tract is changed. The incidental take permit authorized runs concurrent with the 50-year term of the HCP.

Effect of the Take

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

15.2 Coastal Cutthroat Trout

Form and Amount or Extent of Take

Based on the biological effects described above under the "Effects of the Action" section, implementation of the proposed action is likely to cause the incidental take of the coastal cutthroat trout in the form of harass and potentially harm.

Quantifying and detecting that take in terms of individual coastal cutthroat trout is not possible for specific locations because of the variable distribution and abundance of coastal cutthroat trout in the action area. The Service anticipates incidental take of individual coastal cutthroat trout will be difficult to detect or quantify for the following reasons: (1) the low likelihood of finding dead or injured subadults or adults, (2) delayed mortality, (3) the rapid rate of fish decomposition, and (4) the high probability of scavenging by predators. The FWS anticipates that the following form of take will occur as a result of the activities associated with the project:

> Take of coastal cutthroat trout in the form of harassment and potentially harm will occur through the disruption of normal migrating and foraging behaviors associated with direct impacts resulting from elevated sediment levels. Elevated sediment levels are expected to result from diver activities associated with geoduck harvest. The life-history forms expected to be harassed by these activities are anadromous subadult and adult coastal cutthroat trout. The take exempted by this incidental take statement is for:
>
> > Those coastal cutthroat trout that are significantly disrupted during harvest operations associated with the total acreage of surveyed geoduck tracts, which is approximately of 40,800 acres over 6 Management Regions and 10,200 acres per one management region for the 50-year permit period. The total acreage of surveyed tracts fluctuates because newly discovered beds are added, or the status of an existing tract is changed. The

incidental take permit authorized runs concurrent with the 50-year term of the HCP.

Effect of the Take

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

15.3 Marbled Murrelet

Form and Amount or Extent of Take

Based on the biological effects described above under the "Effects of the Action" section, implementation of the proposed action is likely to cause the incidental take of marbled murrelet adults as described below.

- Harm: We anticipate foraging marbled murrelets to be injured or killed by coming into contact with an oil or fuel spill originating from harvest or compliance vessels. This is expected to be a rare occurrence, and likely to occur no more than once during the 50-year term of the HCP.

Effect of Take

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

15.4 California Brown Pelican

Based on the biological effects described above under the "Effects of the Action" section, implementation of the proposed action is likely to cause the incidental take of brown pelicans as described below.

- Harm: We expect foraging brown pelicans to be injured or killed via the ingestion of discarded material or by coming into contact with an oil or fuel spill originating from harvest or compliance vessels. These are expected to be rare occurrences, and are likely to occur no more than once each during the 50-year term of the HCP.

Effect of Take

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

15.5 Bald Eagle

Form and Amount or Extent of Take

Based on the biological effects described above under the "Effects of the Action" section, implementation of the proposed action is likely to cause the incidental take of bald eagles as described below.

- Harassment: We anticipate that bald eagles will be harassed by the proposed action due to disruption of normal behavior patterns of nesting, foraging, and roosting. Of the 2,785 bald eagle sites documented in Washington, 370 sites are located within 0.5 miles of a geoduck commercial harvest tract. Of these, only 178 sites are located within 0.25 miles of a bald eagle site. Of these, only a small proportion of the sites (3-4) are likely to be harassed annually over the 50-year term of the permit.

- Harm: We anticipate that bald eagles will be harmed by the proposed action due to disruption of normal nesting behavior that may result in nest failure. Of the 2,785 bald eagle sites documented in Washington, 370 sites are located within 0.5 miles of a geoduck commercial harvest tract. Of these, only 178 sites are located within 0.25 miles of a bald eagle site. Of these, only a small proportion of the sites (3-4) are likely to be harmed annually over the 50-year term of the permit. We also expect foraging bald eagles to be injured or killed by coming into contact with an oil or fuel spill originating from harvest or compliance vessels. This is expected to be a rare occurrence, and is likely to occur no more than once during the 50-year term of the HCP.

Effect of Take

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

15.6 Tufted Puffin

Form and Amount or Extent of Take

Based on the biological effects described above under the "Effects of the Action" section, implementation of the proposed action is likely to cause the incidental take of tufted puffins as described below.

- Harm: We expect foraging tufted puffins to be injured or killed via the ingestion of discarded material or coming into contact with an oil or fuel spill originating from harvest or compliance vessels. These are expected to be rare occurrences, and are likely to occur no more than once each during the 50-year term of the HCP.

Effect of Take

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

16.0 REASONABLE AND PRUDENT MEASURES

Pursuant to 50 CFR §402.14 (I) (ii), reasonable and prudent measures are those measures the FWS considers necessary to minimize incidental take. The FWS has not identified any reasonable and prudent measures for the proposed project. All conservation measures are provided by the applicant's HCP.

17.0 TERMS AND CONDITIONS

Because the FWS has not identified any reasonable and prudent measures that would reduce the amount or extent of incidental take, no terms and conditions have been established.

Reporting Requirements:

The FWS is to be notified in writing within 3 working days of the accidental death of, or injury to a federally listed species or of the finding of any dead or injured listed species during implementation of the proposed HCP. Notification must include the date, time, and location of the incident or discovery, as well as any pertinent information on circumstances surrounding the incident or discovery. The FWS contact for this written information is the Manager for the Western Washington Fish and Wildlife Office.

18.0 CONSERVATION RECOMMENDATIONS

Sections 2(c) and 7(a)(1) of the Act direct 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 and the ecosystems upon which they depend. Regulations in 50 CFR §402.02 define conservation recommendations as FWS suggestions regarding discretionary agency activities to minimize or avoid adverse effects of a proposed action to listed species or critical habitat, to help implement recovery plans, or develop information.

There are no conservation recommendations for this HCP.

19.0 REINITIATION NOTICE

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

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