United States Department of the Interior

FISH AND WILDLIFE SERVICE

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

AUG 19 2016

In Reply Refer To:
01EWFW00-2016-F-0656

M. Sarah Creachbaum
National Park Service
Olympic National Park
600 East Park Avenue
Port Angeles, Washington 98362-6798

Dear Ms. Creachbaum:

This letter transmits the U. S. Fish and Wildlife Service's (Service) Biological Opinion on the proposed U.S. Highway 101 Lake Crescent and East Beach Road Rehabilitation located in Clallam County, Washington, and its effects on marbled murrelet (*Brachyramphus marmoratus*). Formal consultation on the proposed action was conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). Your March 28, 2016, request for formal consultation was received on April 7, 2016.

The enclosed Biological Opinion is based on information provided in the March 28, 2016, Biological Assessment, the March 17, 2016 draft Environmental Assessment, telephone conversations, field investigations, and other sources of information cited in the Biological Opinion. A complete record of this consultation is on file at the Service's Washington Fish and Wildlife Office in Lacey, Washington.

The Biological Assessment also included a request for Service concurrence with a "not likely to adversely affect" determination for certain listed resources. The enclosed document includes a section separate from the Biological Opinion that addresses your concurrence request. We included a concurrence for northern spotted owl (*Strix occindentalis caurina*). The rationale for this concurrence is included in the concurrence section.

If you have any questions regarding the enclosed Biological Opinion, our response to your concurrence request, or our shared responsibilities under the Act, please contact Teal Waterstrat 360-753-7760, Bill Vogel 360-753-4367 or Carolyn Scafidi 360-753-4068

Sincerely,

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

Enclosure

cc:
NPS, Port Angeles, WA (C. Miller)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
01EWFW00-2016-F-0656

U.S. Highway 101 Lake Crescent and East Beach Road Rehabilitation Project

Clallam County, Washington

Federal Action Agency:

National Park Service

Consultation Conducted By:

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

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

Date 8/19/16

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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practices
CFR	Code of Federal Regulations
dBA	A-weighted decibel level
dbh	diameter-at-breast-height
EA	Environmental Assessment
ESA	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
FR	Federal Register
GIS	Geographic Information System
MP	milepost
MSE	Mechanically Stabilized Earthen walls
murrelet	marbled murrelet
NWFP	Northwest Forest Plan
Opinion	Biological Opinion
Park	Olympic National Park
Project	U.S. Highway 101 Lake Crescent and East Beach Road Rehabilitation Project
PSU	Primary Sampling Unit
RPM	Reasonable and Prudent Measure
Service	U.S. Fish and Wildlife Service

INTRODUCTION

This document represents the U. S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) based on our review of the proposed U.S. Highway 101 Lake Crescent and East Beach Road Rehabilitation Environmental Assessment located in Clallam County, Washington, and its effects on marbled murrelet (*Brachyramphus marmoratus*), in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*)(ESA). Your March 28, 2016, request for formal consultation was received on April 7, 2016.

Marbled murrelet critical habitat was first designated in 1996 (61 FR 26256 [May 24, 1996]), and revised in 2011. (76 FR 61599 [October 5, 2011]). The revised 2011 designation was affirmed on August 4, 2016 (81 FR 51348). While critical habitat has been designated for the marbled murrelet, critical habitat is not present in the action area and will not be affected by the proposed Federal action.

This Opinion is based on information provided in the March 28, 2016, Biological Assessment, the March 17, 2016, draft Environmental Assessment (EA) (NEPA document), telephone conversations, field investigations, and other sources of information as detailed below. A complete record of this consultation is on file at the Service's Washington Fish and Wildlife Office in Lacey, Washington.

CONSULTATION HISTORY

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

- The Biological Assessment was received on April 7, 2016.
- Additional information necessary to initiate consultation was received on April 7, 2106.
- Formal consultation was initiated on April 7, 2016.

CONCURRENCE FOR THE NORTHERN SPOTTED OWL

A detailed description of the proposed action is provided in the EA, and is summarized here. The U.S. Highway 101 Lake Crescent and East Beach Road Rehabilitation (Project) will rehabilitate 12.3 miles of Highway 101 adjacent to Lake Crescent and 4.0 miles of East Beach Road to address safety and long-term maintenance concerns. As part of the rehabilitation of U.S. Highway 101 portion of the project, a Clallam transit shelter is proposed for expansion and upgrading near Barnes Point. Under Alternative 3 (preferred alternative) of the EA daytime work would be conducted between March and November with additional night work occurring between Labor Day (early September) and March 3 over three construction years starting in 2016.

U.S. Highway 101 (Highway 101) has a mix of public recreational, local commuter, and commercial (primarily logging truck) traffic where it transects Olympic National Park (Park).

The section of Highway 101 on the south side of Lake Crescent has substandard and/or failing guardrails, roadside hazards such as missing drop inlet grates, rock fall hazards, and poor pavement conditions (potholes, edge failures, and poor surfacing). Rehabilitation is needed to improve subsurface pavement conditions, apply new pavement, stabilize cut and fill slopes, improve drainage, improve and replace guardrails, mitigate rockfall hazards and improve intersections while protecting natural, cultural and recreational resources within Park.

The Park has committed to a number of conservation measures which are intended to avoid and minimize potential impacts to the northern spotted owl, and has provided information in support of a "may affect, not likely to adversely affect" determination for the northern spotted owl (NPS 2016a, pp. 4-5):

- Adhering to applicable noise and work restrictions as outlined in the 2007 Olympic National Park General Management Plan Biological Opinion (USWFS 2007, p 30):
    - During the breeding season, reduce the number of days of above ambient noise activities utilizing heavy equipment at each project site located within 35 yards of suitable marbled murrelet or northern spotted owl habitat. Restrict the use of jackhammers, rock drills, and pile drivers within 60 yards of suitable habitat during breeding season for northern spotted owls and marbled murrelets.
    - Within or near suitable northern spotted owl during the applicable season, minimize idling of motors when power tools and equipment, including vehicles, are not in use.
    - Muffle above ambient noise whenever possible to reduce noise impacts
- Night work would not occur until well after the early nesting season for northern spotted owls is over starting around Labor Day (early September) each year.
- Lights used for night work will be downcast to reduce light pollution and disturbance.

The action area has been defined to include an area of approximately 900 acres surrounding the Highway 101 and East Beach Road corridor, including the Barnes Point transit stop, staging locations, pullouts, and parking areas.

Forested stands located within the action area do provide suitable northern spotted owl foraging, nesting, roosting, and dispersal habitats. The project will remove a few larger trees which have been surveyed and found not to have northern spotted owl nesting characteristics (NPS 2016, p.119). Proposed activities will not physically remove, or functionally alter, stands providing suitable northern spotted owl habitat (NPS 2016, pp.119, 123).

Northern spotted owl surveys have been conducted in known sites in the project area an average of four times a year since 1992 as part of the Olympic Peninsula Demographic Study Area. Although structurally suitable habitat for northern spotted owls is found in immediate proximity of the project area, ongoing park surveys have indicated that much of this habitat is no longer

used for nesting by northern spotted owls and is instead occupied by barred owls (*Strix varia*) (Gremel pers. comm. 2015). Northern spotted owl pairs were reported in 2015 and 2016 approximately one mile south of Highway 101, but neither nesting nor reproduction occurred (Gremel 2016, p. 6, Gremel, S., pers. comm. 2016).

The Park has determined that temporary increased sound levels associated with construction are likely to exceed ambient background sound levels to a distance of approximately 50 feet (ft). Additional louder and intermittent sounds will be caused by the use of rock drills and pneumatic air hammers. Visual disturbance from increased human and vehicular activity in the action area will occur and are like to cause behavior changes in wildlife. The Park has also determined the need for flood lights for up to a 6-hour period of night work at specific locations such as culvert replacements and substantial road patches. The lighting could cause disruption of normal predator-prey responses in addition to reducing wildlife presence in the vicinity of the work being performed. To the extent possible downcast lighting instead of broadcast lighting sources will be used.

Construction of the proposed project will result in temporary increases in sound, visual and light disturbance for the duration of three or four construction seasons. As stated above, the observations of paired owls have occurred at over a one-mile straight line distance from the construction area. Northern spotted owls on the Olympic Peninsula occupy large home ranges with an average core area equal to a 1.4 mile radius from the nest tree (Forsman et al 2005, p. 370, 375). The project area and light and noise disturbance beyond the immediate physical Project footprint would be within the home range and core area of at least one northern spotted owl pair. The core area and home range areas overlap Lake Crescent and Highway 101 (along its immediate southern bank). Highways and large water bodies are not considered northern spotted owl habitat making it unlikely that a northern spotted owl would utilize the lake and the immediately adjacent highway despite suitable habitat up to the lake and highway's edge. Based on evidence presented by the Park documentation of the absence of current reproduction, the ongoing demographic monitoring, and the increasing presence of barred owls [and correlated decrease in northern spotted owls (Dugger et al 2016, p 98)] it is extremely unlikely the northern spotted owls would nest within the action area (e.g., so direct disturbance to nesting northern spotted owls is considered to be discountable.

Rock scaling and drilling, the loudest anticipated noises in the Project, are anticipated to occur during late August, after the northern spotted owl early nesting season (March 1 to July 15). During the late northern spotted owl nesting season (July 31 through September 30), chicks have typically fledged, are able to thermoregulate, fly short distances, and are no longer completely dependent upon the adults for daily feeding (Forsman et al. 1984, pp. 37-38). After July 31, the foreseeable temporary, construction-related exposures to elevated levels of disturbance are unlikely to affect nest success or result in measurable effects to the growth, health, or fitness of adult or juvenile northern spotted owls.

There will be increased visual disturbance from artificial light sources used during night time work starting in early August and continuing through March 3 of each calendar year. The lighting will be downward cast to the extent possible will and powered by portable generators. The artificial light will likely only extend a short distance outside the project area due to the

downwards orientation of the lights. Lighting could cause northern spotted owls to be distracted or attracted to the glare in the area. Lighting could affect the behavior of northern spotted owls by exposing them to lighting in the project area. Foraging and dispersing northern spotted owls may therefore experience temporary elevated levels of disturbance from light sources. However, there is extensive higher quality habitat available within the potential core area and home range that the owls could utilize without having measurable impacts to their ability to forage and disperse through the landscape. For the reasons stated above is highly unlikely that northern spotted owls will be negatively impacted by artificial light sources.

The proposed action will have no foreseeable adverse effects to northern spotted owls, their prey base, or habitat. With successful implementation of the agreed-upon conservation measures, it is extremely unlikely that active northern spotted owl nests will be exposed to any construction related activities, noise, or light disturbance during the early nesting season (March 1 to July 15). Furthermore, the Service expects that any temporary exposure to construction activities conducted during the late nesting season (July 16 to September 30) will not affect nest success or result in measurable effects to the growth, health, or fitness of adult or juvenile northern spotted owls. It is possible that Project activities may result in short-term disturbance or temporary displacement of non-nesting northern spotted owls that may be moving through their home range. Such flush responses that occur away from an active nest site are considered to be insignificant, because the owls are simply moving away from a source of disturbance, rather than being forced to flush away from an active nest site. With successful implementation of the agreed-upon conservation measures, the proposed action's temporary effects will not measurably or significantly disrupt normal northern spotted owl behaviors (i.e., the ability to successfully feed, move, and/or shelter) and are therefore considered insignificant.

The proposed action will not physically remove or functionally alter stands providing suitable northern spotted owl habitat, and will have no measurable effect on the northern spotted owl prey base or availability of food resources. The action will not construct new points of access or increase traffic or visitor capacity. No future development proposals or major Park actions are contingent or dependent upon the action. The Service expects that no discernible changes in the rate or pattern of land use conversion will result, in whole or in part, from the action. We also expect that no discernible changes in long-term public use or management of the Park will result from the proposed action beyond that expected by state population growth in the region (Washington State 2015, p. 4). Foreseeable effects to the northern spotted owl, their prey base, and habitats will be minor and limited to loss of a few trees, shrubs, and understory vegetation, and are therefore considered insignificant. For these reasons, the Service concurs with the Park's determination of "may affect, not likely to adversely affect" for the northern spotted owl.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

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

The National Park Service proposes to rehabilitate approximately 16.3 miles of roadway within the Park, including U.S. Highway 101 (Highway 101) Lake Crescent and East Beach Road. The Project will rehabilitate 12.3 miles of Highway 101 adjacent to Lake Crescent and 4.0 miles of East Beach Road to address safety and long-term maintenance concerns. This Project is considered beyond the scope of the routine road maintenance program. As part of the rehabilitation of U.S. Highway 101 portion of the project, a Clallam transit shelter is proposed for expansion and upgrading near Barnes Point. Under Alternative 3 (preferred alternative) of the EA, daytime work would be conducted between March and November with additional night work occurring between Labor Day (early September) and March over three or four construction years starting in 2016. No lighting is currently present along Highway 101 or East Beach Road in the project area and none would be added under the proposed project

Highway 101 has a mix of public recreational, local commuter, and commercial (primarily logging truck) traffic where it transects the Park. The section of Highway 101 on the south side of Lake Crescent has substandard and/or failing guardrails, roadside hazards such as missing drop inlet grates, rock fall hazards, and poor pavement conditions (potholes, edge failures, and poor surfacing). Rehabilitation is needed to improve subsurface pavement conditions (deep patches), apply new pavement, stabilize cut and fill slopes, improve drainage, improve and replace guardrails, mitigate rockfall hazards and improve intersections.

Work specific to Highway 101 will include the use of heavy machinery, large vehicles, power, and hand tools (such as rock drills) to:

- Modify pavement by excavating one or both lanes of the roadway and replace of fill material (deep patches);
- Construct of mechanically stabilized earthen (MSE) walls;
- Fix existing gabion walls
- Add riprap along the edge of proposed and existing retaining walls along the lake shoreline
- Improve of drainage across the roads through culvert replacement and repair
- Replace guardrails
- Mitigate rockfall hazards

- Improve Sledgehammer Point by building and extending the rock walls to reduce downslope impacts and improve interpretive exhibits

- Construct Barnes Point Transit Stop

- Modify turnouts along Lake Crescent

Work along East Beach Road includes the use of heavy machinery, large vehicles, power, and hand tools to conduct the following:

- New asphalt pavement surfacing from milepost (MP) 3.9 to 7.2; from MP 0 – 0.5 on the East Beach Road Extension (up to the Lyre River Bridge); and from MP 0 – 0.2 on Waterline Road

- Hanging culvert improvement (7-foot culvert near Log Cabin Resort)

- Replacement of approximately nine culverts in poor condition to improve drainage

- Striping and signing

Anticipated noise for most road rehabilitation activities is summarized in Table 1 from the Park's EA to help describe the extent and loudness of noise generation by the loudest of the activities at 50 ft from the source.

Table 1. Sound Pressure Levels Associated with Typical Road Construction Noise Sources

Equipment	**Typical Noise Level (dBA) 50 feet from source**	**Equipment**	**Typical Noise Level (dBA) 50 feet from source**
Air Compressor	81 -85	Loader	80- 87
Backhoe	80 - 84	Paver	80 - 89
Compactor	80 -82	Pneumatic Tool	85
Concrete Mixer	85	Pump	77 - 85
Bulldozer	84 - 88	Rock Drill	85 - 98
Generator	78 - 84	Roller	74 - 80
Grader	85	Saw	76
Jack Hammer	85 - 89	Scraper	85 - 89

Source: In 1994 and 1995 Harris Miller, Miller & Hanson Inc. performed noise studies for the Central Artery/Tunnel project in Boston. The results of this study are summarized in FHWA Work Zone Report (and) FHWA website 2004 (*in* NPS YOSE 2008)

The Park has identified suitable staging locations, including Sledgehammer point, Wallace Point, and the former Aurora Quarry. We expect that the Park and their chosen Contractor(s) may also use additional sites in support of construction. There are an additional three WSDOT maintenance yards (from west to east: Heckelsville at MP 214.5, Useless Pit at MP 231.5, and Elwha at MP 238.5) that could also be used at the contractor's discretion.

There will not be detour routes during construction, but delays in traffic are expected as a result of the proposed work. Therefore, we assume for the purposes of defining action area and assessing potential effects, that there will be no temporary detours outside of the roads proposed for rehabilitation.

Conservation Measures for the Marbled Murrelet

1. Limit night work until late in the murrelet nesting season (after Labor Day) when most chicks are reported to have left forested areas for marine waters.

2. Night construction will begin one hour after sunset, and will cease one hour prior to sunrise, from April 1 to September 23. This restriction would not apply to nighttime activities conducted between September 23 and April 1 of each calendar year.

3. Implement standard noise abatement measures during the project, including: scheduling to minimize impacts in noise-sensitive areas, using the best available noise control techniques wherever feasible, using hydraulically or electrically powered impact tools when feasible, and locating stationary noise sources as far from sensitive uses as possible.

4. Minimize idling of motors when power tools, equipment, and vehicles are not in use.

5. Muffle above ambient noise whenever possible to reduce noise impacts.

6. Protect and preserve critical habitat features, such as potential nest trees, whenever possible.

Action Area

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment. The action area for this proposed federal action is based on the geographic extent of noise or light from the road rehabilitation and repair as depicted in Figure 1. Therefore, the action area for this consultation includes all road rehabilitation areas, as well as staging areas, and adjacent areas out to the distance at which sound levels attenuate to ambient, background levels. Using the Washington Department of Transportation's construction noise impact assessment calculator and acoustical monitoring in the forest environment from Mount Rainier National Park, we estimate that the distance at which noise would attenuate to ambient levels may be as a far as 0.5 mile, depending on local topography (National Park Service 2011, p. 13; WSDOT 2013, chapter 7).

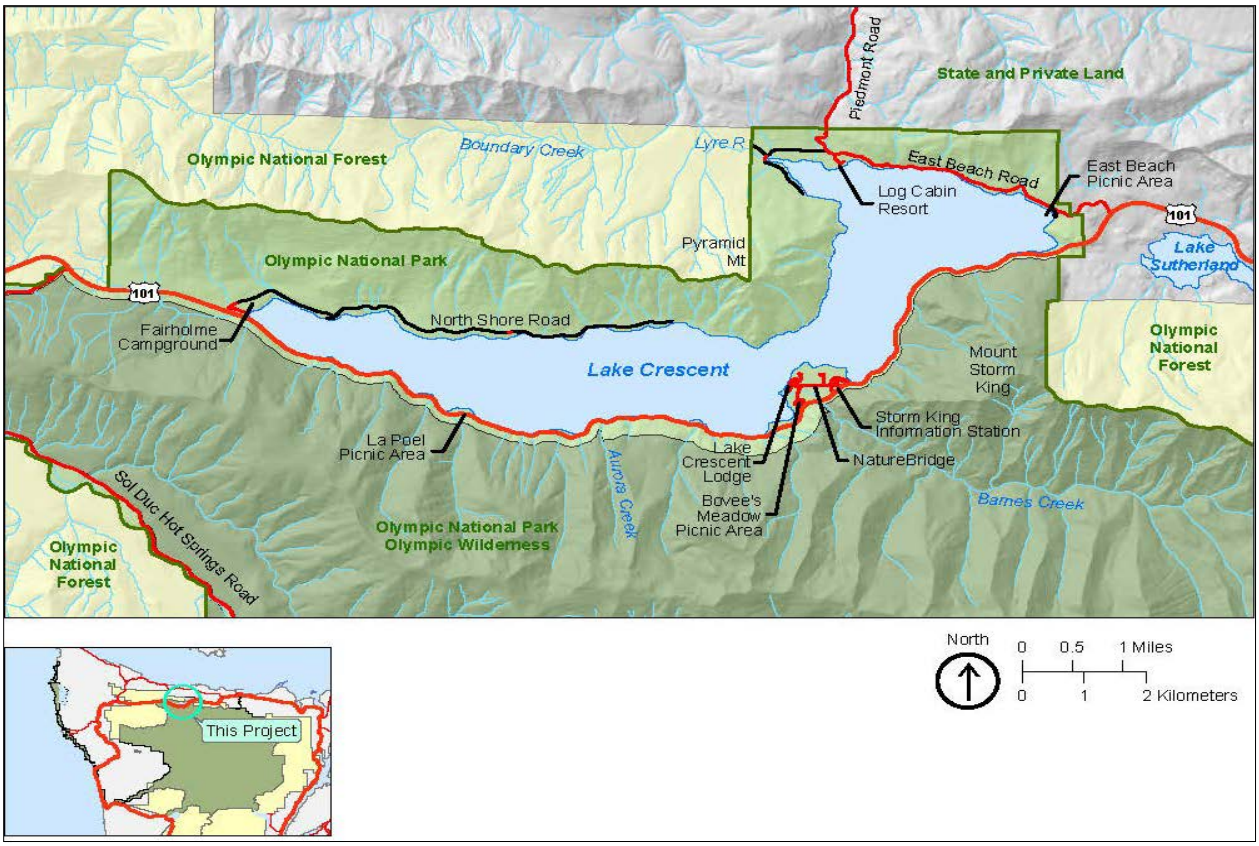

Figure 1: General project location map for the Lake Crescent and East Beach Road Rehabilitation Project.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Jeopardy Determination

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

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

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

STATUS OF THE SPECIES: Marbled Murrelet

The marbled murrelet (murrelet) was listed as a threatened species in Washington, Oregon, and northern California in 1992. The primary reasons for listing included extensive loss and fragmentation of old-growth forests which serve as nesting habitat for murrelets and human-induced mortality in the marine environment from gillnets and oil spills (57 FR 45328 [Oct. 1, 1992]). Although some threats such as gillnet mortality and loss of nesting habitat on Federal lands have been reduced since the 1992 listing, the primary threats to species persistence continue (75 FR 3424 [Jan. 21, 2010]).

Although murrelets are generally associated with mature and old-growth forest habitat, they also have been found in younger forests with structural elements similar to old growth, such as remnant old-growth trees or younger trees with platforms created by deformities or dwarf mistletoe infestations (Grenier and Nelson 1997, p. 193 in Ralph et al. 1997). The most basic unit of murrelet nesting habitat is individual trees with suitable nest platforms. A platform is defined as a relatively flat surface at least 10 cm (4 inches) in diameter and 10 m (33 ft) high in the live crown of a coniferous tree. Platforms can be created by a wide bare branch, moss, or lichen covering a branch, mistletoe, witches brooms, and other deformities. Any forested area with a residual tree component, small patches of residual trees, or one or more platforms is potential murrelet nesting habitat (Evans Mack et al. 2003, p. 3).

Surveys from 2001 to 2013 indicated that murrelet populations at the conservation-zone scale, show strong evidence of a linear decline in the two conservation zones in Washington: a 3.9-percent decline per year in Conservation Zone 1, which includes the Strait of Juan de Fuca, San Juan Islands, and Puget Sound, and a 6.7-percent decline per year in Conservation Zone 2, which includes the outer coast of Washington, no evidence of a linear trend in Zone 3 or Zone 5, and a positive trend in Zone 4 (Falxa and Raphael. 2016, p. 26). While the direct causes for the population declines are unknown, potential factors include the loss of nesting habitat, including cumulative and time-lag effects of habitat losses over the past 20 years (an individual murrelets potential lifespan), changes in the marine environment reducing the availability or quality of prey, increased densities of nest predators, and emigration (Miller et al. 2012, p. 778). The most recent population estimate for the Northwest Forest Plan area in 2013 was 19,600 murrelets (95 percent confidence interval: 15,400 to 23,800 birds) (Falxa and Raphael 2016, p. 131). The largest and most stable murrelet subpopulations now occur off the Oregon and northern California coasts, while subpopulations in Washington have experienced the greatest rates of decline (-3.9 to -7.4 percent per year) (Falxa and Raphael. 2016, p. 4).

The loss of nesting habitat was a major cause of the murrelet's decline over the past century and may still be contributing as nesting habitat continues to be lost to fires, logging, and wind storms (Miller et al. 2012, p. 778). Monitoring of murrelet nesting habitat in the Northwest Forest Plan

area from 1994 to 2012 indicates nesting habitat declined from 2.53 to 2.23 million acres during the monitoring period, a loss of about 12 percent (Falxa and Raphael 2016, p. 72). Fire has been the major cause of nesting habitat loss on Federal lands, while timber harvest is the primary cause of loss on non-Federal lands. The rate of loss of higher suitability habitat on reserved lands has been about 2.5 percent over the 20-year period. However, rate of loss of higher suitability habitat has been about 10 times greater (26.6 percent) on nonfederal lands, owing mostly to timber harvest (Falxa and Raphael 2016, p 86). Murrelet population size is strongly and positively correlated with amount of nesting habitat, suggesting that conservation of remaining nesting habitat and restoration of currently unsuitable habitat is key to murrelet recovery (Raphael et al. 2011, p. iii). Conservation of the threatened murrelet is not possible if habitat losses continue at this rate into the future (Falxa and Raphael 2016, p 86).

Detailed information regarding the status, threats, life history and conservation needs of the murrelet are presented in the Service's *Marbled Murrelet Recovery Implementation Team Report* (USFWS 2012), the *5-year Status Review for the Marbled Murrelet* (USFWS 2009), the *Recovery Plan for the Marbled Murrelet* (USFWS 1997*)*, and Appendix A: Status of the Species: Marbled Murrelet of this Opinion.

ENVIRONMENTAL BASELINE: Marbled Murrelet

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

The environmental baseline analysis for the murrelet also describes the relationship of the current condition and conservation role of the action area to murrelet recovery units. The *Recovery Plan for the Marbled Murrelet* identifies 6 broad "Marbled Murrelet Conservation Zones" across the listed range of the species to geographically define recovery goals and objectives. In Washington, there are two Conservation Zones: Puget Sound (Conservation Zone 1) and Western Washington Coast Range (Conservation Zone 2) (USFWS 1997, p. 114). Murrelet potential nesting habitat and population estimates for the Conservation Zones in Washington are summarized in Table 2**.**

The action area for the proposed road rehabilitation includes Conservation Zone 1 and is adjacent to Conservation zone 2.

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 United States-Canadian border and extends inland 55 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 Conservation Zone 1 is typically a considerable distance from the marine environment, lending special importance to nesting habitat close to Puget Sound (USFWS 1997, p.125).

Conservation Zone 2

Conservation Zone 2 includes marine waters within 1.2 miles of the Pacific Ocean shoreline south of the U.S.-Canadian border off Cape Flattery and extends south to the mouth of the Columbia River, and extends inland to the midpoint of the Olympic Peninsula and 55 miles inland in southwestern Washington. Most of the forested lands in the northwestern portion of Conservation Zone 2 occur on public (Federal and state) lands, while most of the forested lands in the southwestern portion are privately owned. Extensive timber harvest has occurred throughout Conservation Zone 2 in the last century, but the greatest losses of suitable nesting habitat occurred in the southwest portion of Conservation Zone 2 (USFWS 1997, p. 127).

Table 2. Summary of murrelet nesting habitat distribution and populations in Washington.

Murrelet Conservation Zone	**Murrelet habitat on federal lands (acres)**	**Murrelet habitat on non-federal lands (acres)**	**Total murrelet habitat in Conservation Zone (acres)**	**Estimated murrelet population (2015) and 95 % confidence intervals**	**Estimated annual population trend (2001-2015)**
Zone 1 – Puget Sound and Strait of Juan de Fuca	532,285	207,112	739,407	4,290 (2,783 – 6,492)	-5.3 %
Zone 2 – Washington Coast	353,800	256,783	603,777	3,204 (1,883 – 5,609)	-2.8 %
Totals	886,085	463,905	1,343,184	7,494	-4.4 %

Note: All habitat figures are approximate values derived from GIS data. Totals were computed prior to rounding. Marbled murrelet habitat estimates represent approximate conditions in 2012, as depicted by Falxa and Raphael. (2015 and 2016) map data, moderate (class 3) and highest (class 4) suitability. Murrelet population and trend estimates for the year 2015 are from Lance and Pearson (2016, p. i).

Status of Marbled Murrelets within Olympic National Park

The Park is the largest contiguous block of suitable nesting habitat remaining within the range of murrelets in the lower 48 states. Murrelets occur within all the major drainages below about 3,000 feet elevation in the park. Suitable habitat includes forests up to 3,500 feet elevation on the east side of the park, and forests up to 3,000 feet on the west side of the park (NPS 2016, p 71).

Landscape models of murrelet nesting habitat developed for the Northwest Forest Plan (NWFP) (Raphael et al. 2015) indicate over 322,000 acres of potential murrelet nesting habitat on the Olympic Peninsula are located within the boundaries of the Park (Table 3). Nesting habitat within the Park represents about 43 percent of the potential murrelet nesting habitat located on the Olympic Peninsula. Most of the murrelet habitat within the Park is located within designated wilderness areas.

Table 3. Summary of land ownerships and distribution of potential murrelet nesting habitat on the Olympic Peninsula.

	Olympic Peninsula	
Land Ownership	**Total land area (acres)**	**Murrelet nesting habitat (acres)**
Olympic National Forest	630,746	221,466
Olympic National Park	900,072	322,993
Other lands: State, Tribal, Private	1,500,106	211,398
Totals	3,030,924	755,857

Note: Marbled murrelet habitat estimates represent approximate conditions in 2012, as depicted by map data developed for the NWFP monitoring program, moderate (class 3) and highest (class 4) suitability (Raphael et al. 2015, p. 121).

Inland surveys have been conducted in the Park according to Pacific Seabird Group protocols in all developed areas and in a sampling of backcountry valleys from 1995 to 1999 (Hall 2000). Murrelet presence has been documented at every site surveyed in the Park. Detections indicating occupancy behavior have been documented at approximately 83 percent of sites surveyed within the Park (Hall 2000). The surveys indicate that murrelet detections generally peak in July and taper off at the beginning of August. Raphael et al. (2002) used radar to count numbers of murrelets flying inland within 10 river drainages on the Olympic Peninsula. Murrelets were detected in each of the drainages monitored, and the total number of murrelets counted was strongly correlated with the total amount of nesting habitat in the watershed. The Queets, Upper Quinault, and Elwha drainages within the Park had the highest counts of murrelets detected. Based on the data presented by Hall (2000) and Raphael et al. (2002), we expect that all suitable

murrelet habitat within the Park is occupied by murrelets. The density of murrelets occupying nesting habitat in the Park is unknown. Raphael et al. (2002) estimated an average density of 1 nesting pair per 150 ha (370 acres) of habitat on the Olympic Peninsula, but acknowledged the murrelets likely occur at higher densities in some locations.

Current Condition of the Species in the Action Area

The portion of the Park of interest to this consultation and the entirety of Lake Crescent are located in marbled murrelet Conservation Zone 1. However the entire project is very close to Conservation Zone 2 it is likely that murrelets counted at sea or observed flying over land could be utilizing both recovery zones (Figure 1). Much of the Puget Trough's mature forest has been replaced by urban and suburban development. The suitable marbled murrelet habitat remaining in the eastern portion of Conservation Zone 1 is typically a considerable distance from the marine environment, lending special importance to habitats close to Puget Sound such as this one (USFWS 1997, p.125).

Murrelet nesting habitat at the project site is degraded by the presence of open roads that receive high levels of public use during the summer months and traffic throughout the year. The action area includes marbled murrelet nesting habitat located adjacent to campgrounds, resort lodges, and recreational centers that are subject to high levels of human disturbance during the summer months. These facilities attract corvids (crows, ravens, and jays) which can increase risk of nest predation for murrelets (Marzluff and Neatherlin 2006, p. 308). Although relatively few murrelet nest sites have been found near open roads or campgrounds, murrelets do occasionally nest successfully in such areas and appear to habituate to the normal range of sounds and activities associated with these areas (Hamer and Nelson 1998, p. 21, Bloxton and Raphael 2009, pp. 11-12).

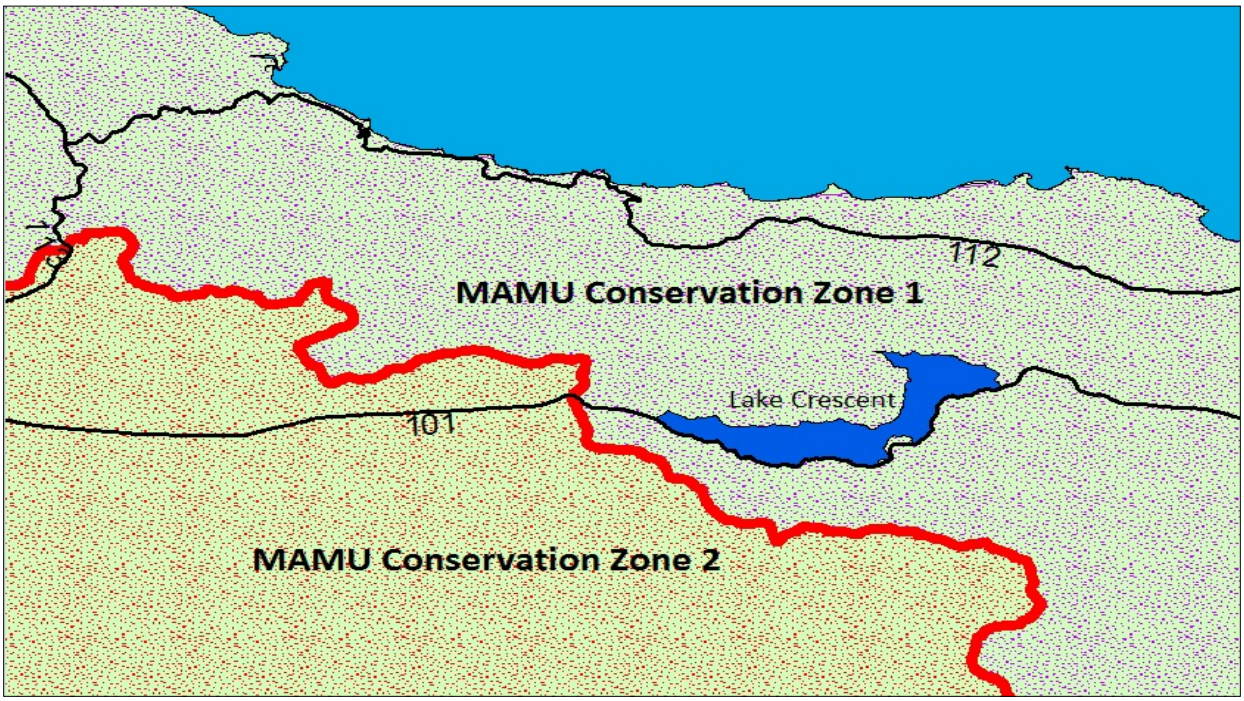

Figure 2. Proximity of Lake Crescent and the project area to marbled murrelet Conservation Zones 1 and 2.

Murrelets currently use suitable habitat within the action area. Surveys for murrelets in the project area have found that murrelets occur in suitable habitat adjacent to Lake Crescent. In addition, there has been at least one reliable occurrence of murrelets observed on the lake itself. Since most activity away from the nest occurs on saltwater, this was noted as unusual (Gremel pers. comm. 2015).

A preliminary murrelet habitat survey was conducted during February 2015, following the guidelines published by the Service (Evans-Mack et. al 2003). Suitable habitat is defined as having platforms greater than 4 inches across in coniferous trees, above 33 feet in height, with suitable vertical cover by limbs or foliage, and located within an area of contiguous forest. The survey of habitat along the Lake Crescent corridor of Highway 101 determined that much of that area is suitable habitat. Similarly, the project area along East Beach Road is considered suitable habitat. Although there was evidence of fire in probably the last 100 years, many large, older coniferous trees were present within nearly all the younger forest stands. Most trees in this older age class had structures that could potentially support murrelet nests, and these older trees were well distributed along the highway corridor (Gremel pers. comm. 2015). Modeled estimates of suitable habitat within the action area find that roughly 1,276 acres are within a quarter mile of the proposed project.

The nearest marine habitat for reproductive and non-reproductive adult and juvenile murrelets is located to the north in the Strait of Juan de Fuca. This habitat is regularly surveyed by Washington Department of Fish and Wildlife for murrelets as part of the "At –Sea Marbled Murrelet Population Monitoring Program" to monitor the effectiveness of the NWFP since 2000 (Lance and Pearson 2015, p. 1). The primary sampling units (PSUs) three, five, and six in Conservation Zone 1 have typically supported the highest densities of observed murrelets during the time of year construction is likely to proceed (Figure 2).

Because surveys have observed high densities of marbled murrelets in marine waters adjacent to the action area, on Lake Crescent, and in suitable upland habitat surrounding Lake Crescent, we are reasonably certain that the action area is occupied by murrelets. Because murrelets nest at low densities, and the action are represents relatively small area of habitat within the Park, the number of murrelets likely to be nesting in the action area is likely very low.

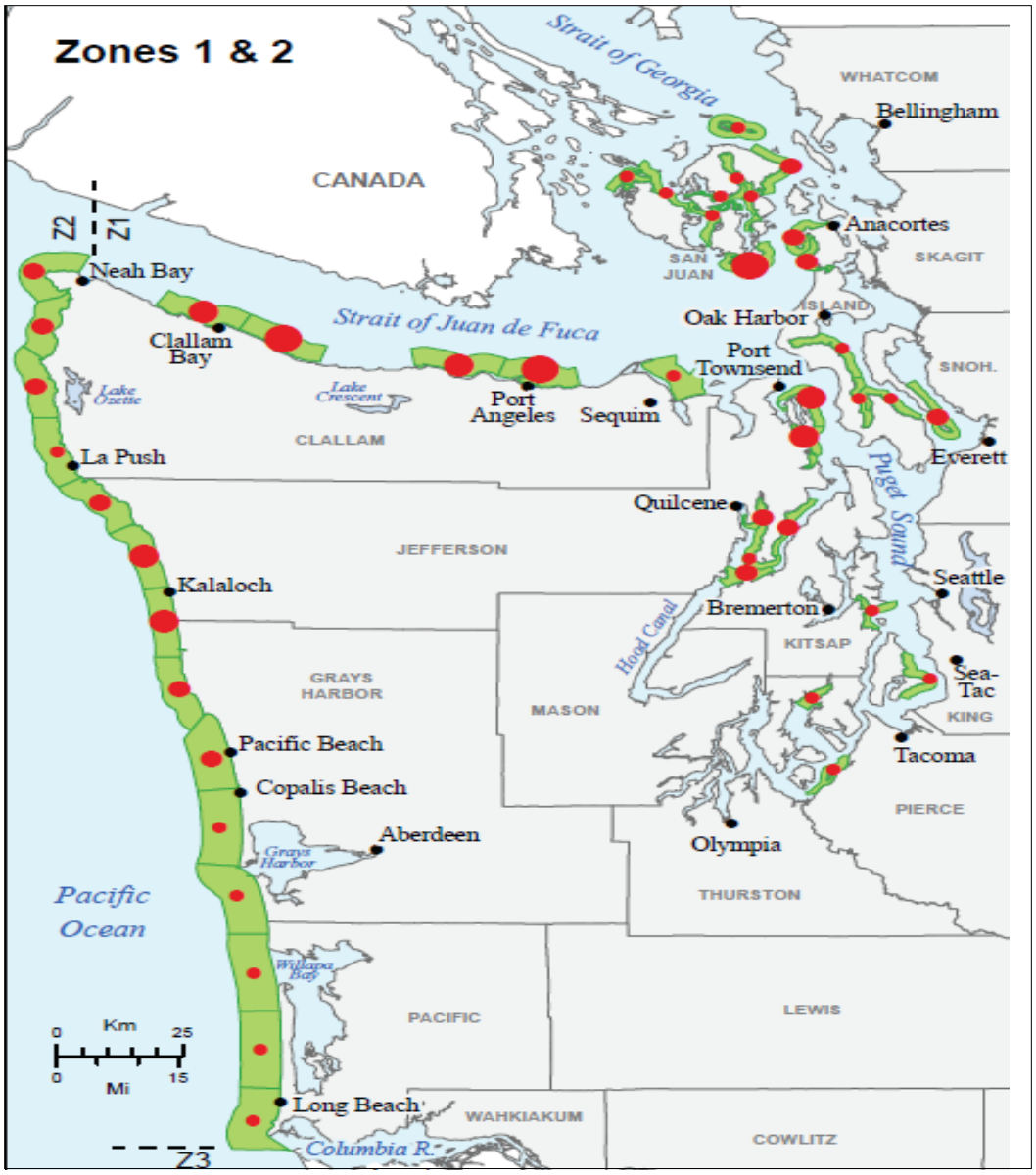

Figure 3: Average marbled murrelet densities at sea by PSU for each conservation zone. Based on mean densities from 2000 to 2013.
Image replicated from Falxa and Raphael 2016 (p. 19).

Conservation Role of the Action Area

Lands considered essential for the recovery of the marbled murrelet within Conservation Zones 1 and 2 include: (1) any suitable habitat in a Late-Successional Reserve; (2) all suitable habitat located in the Olympic Adaptive Management Area; (3) large areas of suitable nesting habitat outside of Late-Successional Reserves on Federal lands, such as habitat located in the Park; (4) suitable habitat on State lands within 40 miles of the coast; and (5) habitat within occupied marbled murrelet sites on private lands (USFWS 1997, pp. 131-134).

The Park provides large, contiguous blocks of suitable marbled murrelet nesting habitat. Because much of the Park is designated Wilderness, much of the highest quality murrelet nesting habitat is undisturbed by development or human activity. Nesting habitats present within the Park are considered essential for the long-term conservation and recovery of the species (USFWS 1997, pp. 131-134). Nesting habitat in the action areas is located in "frontcountry management zones" as defined as "developed" areas in the Park General Management Plan. These areas generally provide lower quality habitat for murrelets because of human presence, increased corvid populations, and noise associated with the use and management of these areas.

Climate Change

During the next 20 to 40 years, the climate of the Pacific Northwest is projected to change significantly with associated changes to forested ecosystems. Predicted changes include warmer, drier summers and warmer, wetter autumns and winters, resulting in diminished snowpack, earlier snowmelt, and an increase in extreme heat waves and precipitation events (Salathe Jr et al. 2010). Initially, the Pacific Northwest is likely to see increased forest growth region-wide over the next few decades due to increased winter precipitation and longer growing seasons; however, forest growth is expected to decrease as temperatures increase and trees can no longer benefit from the increased winter precipitation and longer growing seasons (Littel et al. 2009, p. 15). Additionally, the changing climate will likely alter forest ecosystems as a result of the frequency, intensity, duration, and timing of disturbance factors such as fire, drought, introduced species, insect and pathogen outbreaks, hurricanes, windstorms, ice storms, landslides, and flooding (Littel et al. 2009, p. 14).

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

Within the marine environment, effects on the murrelet food supply (amount, distribution, quality) provide the most likely mechanism for climate change impacts to murrelets. Studies in British Columbia (Norris et al. 2007) and California (Becker and Beissinger 2006) have documented long-term declines in the quality of murrelet prey, and one of these studies (Becker and Beissinger 2006, p. 475) linked variation in coastal water temperatures, murrelet prey quality during pre-breeding, and murrelet reproductive success. These studies indicate that murrelet recovery may be affected as long-term trends in ocean climate conditions affect prey resources and murrelet reproductive rates. While seabirds such as the murrelet have life-history strategies adapted to variable marine environments, ongoing and future climate change could present changes of a rapidity and scope outside the adaptive range of murrelets (USFWS 2009, p.46).

An analysis of climate change impacts on the Olympic Peninsula summarized the following projected climate change effects (Halofsky et al. 2011, p. 13):

1. Climate models project increases in annual average temperature of +0.6 °C to +1.9 °C by the 2020s; +0.9 °C to +2.9 °C by the 2040s; and +1.6 °C to +5.4 °C by the 2080s for the Pacific Northwest.

2. Warming is expected to occur during all seasons, with most models projecting the largest temperature increases in summer.

3. Ensemble means of models for precipitation suggest wetter winters (+3.3 percent in the 2040s, +7.6 percent in the 2080s) and drier summers (-8.5 percent in the 2040s, -12.8 percent in the 2080s).

4. Winter precipitation on the Olympic Peninsula is likely to increase by 4.5 to 5 percent, on average and depending on location.

5. In addition to increased precipitation quantity, regional climate models show significant increases in the intensity of winter precipitation in the western portion of the Olympic Peninsula.

EFFECTS OF THE ACTION: Marbled Murrelet

The effects of the action refers to the direct and indirect effects of an action on the species together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The proposed action will affect murrelets by exposing nesting murrelets to noise and visual disturbance associated with road construction and repair activities. The Service expects that nearly all of the action's measurable effects to murrelets will be temporary and construction-related. Construction of the proposed project will result in temporary increases in sound, visual, and light disturbance over a period of three or four construction seasons (April through October). Murrelets that nest in the vicinity of construction activities will experience temporary elevated levels of construction-related disturbance. The effects to murrelets can range from minor behavioral responses such as briefly alerting or orienting towards distant sounds or lights; to more severe responses such as flushing from a nest or disrupting chick feedings.

Insignificant and Discountable Effects

Some of the proposed action's potential effects to the murrelet are insignificant or discountable. Effects to murrelets resulting from the following activities are considered extremely unlikely to occur (discountable), or the effects will not be measurable or detectable (insignificant):

- All Project activities conducted either before or after the murrelet nesting season (defined in Washington as April 1 to September 23). While murrelets are known to visit inland nesting stands throughout the year, the effects of project activities that occur outside the murrelet nesting season are considered to be insignificant because murrelets are not engaged in nesting behaviors during these other periods of the year.

- Routine hauling and transport of equipment and materials along the project corridor. Highway 101 is a busy transportation corridor. Moving vehicles along the highway are not anticipated to disrupt murrelet nesting behaviors, and are considered to have insignificant effects to murrelets.

- Direct physical disturbance or destruction of active murrelet nests or eggs. No trees with suitable nest platforms will be felled, so the potential for direct mortality of murrelet eggs or nestlings associated with tree felling is considered to be discountable.

Effects to Marbled Murrelet Habitat

The proposed action will not physically remove or functionally alter stands providing suitable murrelet habitat. Most of the proposed work can and will be constructed within the limits (or footprint) of the existing, developed road prism, existing pullouts, parking areas, and other facilities. The Park will conduct a field review of work and staging locations in advance of construction activities.

Work at locations requiring new or modified crib walls, mechanically stabilized earthen walls (MSE), or culvert repair or replacement, and the construction of a new transit station, will result in some amount of unavoidable clearing of areas beyond the developed road prism. A small number of conifers are proposed for removal near the MSE walls and deep patches. Those conifers were inspected by Park biologists for characteristics of murrelet trees and did not meet the definition of a nest tree per Service protocol standards (Evans-Mack et. al 2003, entire). The Park biologists have surveyed the clearing limits at these locations and have determined that mature, but not suitable nesting vegetation will or may be removed. Conifers include (but may not be limited to) a 36-inch diameter at breast height (dbh) cedar near Eagle Creek; a 40-inch dbh Douglas-fir near one of the MSE walls; two 16-inch dbh Douglas-firs adjacent to proposed deep patches; and two cedars (28 and 30-inches dbh), two Douglas-firs (20 and 24-inches dbh) (sizes approximate). Some of these trees may be retained, depending on actual project staking within the proposed construction areas for culvert replacement, deep patches and MSE walls and the ability to use tree protection measures, such as tree wells.

None of the trees currently planned for removal meets the criteria for a suitable and potentially occupied murrelet nest tree. Due to the location and exposure of the trees to be removed, it is also extremely unlikely that an adjacent active murrelet nest might be encountered or damaged when removing these trees.

We conclude that the removal of some larger trees at one or more locations will have insignificant effects to murrelet nesting habitat. The proposed action is unlikely to have any measurable or detectable effect on long-term function or productivity of the stand. Effects to suitable and potentially occupied habitat would be focused directly adjacent to the existing, developed road prism, existing pullouts, parking areas, and other facilities. The action will have no effect on the core-to-interior ratio of available nesting acreage, nest patch size, or the average density of available murrelet nest trees and platforms. The action will not cause or contribute to significant crowding or displacement of breeding pairs, and will not increase the long-term risk of predation.

The proposed action will not construct new points of access or increase traffic or visitor capacity. No future development proposals or major Park actions are contingent or dependent upon the action. The Service expects that no discernible changes in the rate or pattern of land use conversion will result, in whole or in part, from the action. We also expect that no discernible changes in long-term public use or management of the Park will result from the proposed action.

Adverse Effects of the Action

The use of excavators, dump trucks, and other motorized equipment in close proximity to murrelet habitat will disrupt normal murrelet nesting behaviors if the activities coincide with the murrelet nesting season. The Service has previously completed analyses for noise and visual disturbance to murrelets (USFWS 2013, pp. 101-110). In these analyses, we concluded that normal murrelet nesting behaviors are likely to be disrupted by loud noises that occur in close proximity to an active nest or when the activity occurs within the line-of-sight of a nesting murrelet.

Potential murrelet responses to disturbance include delay or avoidance of nest establishment, flushing of an adult from a nest or branch within nesting habitat, aborted or delayed feeding of juveniles, or increased vigilance/alert behaviors of adults and chicks at nest sites with implications for reduced individual fitness and reduced nesting success. These behavioral disruptions create a likelihood of injury by increasing the risk of predation, reducing the fitness of nestlings as a result of missed feedings, and/or increasing energetic costs to adults that must make additional foraging trips. We do not expect that noise and visual disturbance will result in direct nest failure, but exposure to disturbance creates a likelihood of injury due to an increased risk of predation or through reduced fitness of both adults and young.

Evaluation Criteria

A significant disruption of normal murrelet nesting behaviors due to noise and visual disturbance is reasonably certain to occur when ground-based activity occurs during the nesting season within 110 yards of a nest site. This disruption threshold distance is based on recommendations from murrelet researchers that advised buffers of greater than 110 yards to reduce potential noise and visual disturbance to murrelets (Hamer and Nelson 1998, p. 13).

The intensity, frequency, duration, and magnitude of a disturbance event are all important factors the Service considers in the evaluation of disturbance effects. In general, we consider low intensity, short-duration actions (e.g., less than 1 day at a site) to be of much lower risk for disrupting murrelet nesting when compared to prolonged actions that require several days or weeks at a site to complete.

Noise and project activities that occur beyond the disruption distance thresholds listed above are likely to expose nesting murrelets to low-level above-ambient sounds out to distances of 0.25 mile or more. Low-level project sounds that are detectable to murrelets at distances beyond the 110-yard disruption threshold may affect murrelets by triggering minor behavioral responses, such as scanning or head-turning behaviors, or increased vigilance for short periods. Such minor behavioral responses are considered to have insignificant effects to nesting murrelets.

Exposure of Marbled Murrelet Habitat to Noise and Visual Disturbance

Road repairs activities in the project area will occur from late March through November over three construction seasons. The construction season entirely overlaps the murrelet nesting season (April 1 through September 23), so murrelets may be exposed to construction disturbance effects during any part of the nesting cycle, including nest establishment and egg-laying, incubation, and brooding of nestlings through fledging. Each project site will have several days of intensive activity. Murrelets nesting within a distance of 100 m of road repair sites will be exposed to noise and visual disturbance effects over a period of several days at each specific construction site while activities are underway.

Using GIS, we estimated a cumulative total of 1,170 acres are located within the defined 110-yard distance threshold from the road repair sites within the Project action area. This differs slightly from the estimated 900 acres the Park calculated. Because the project sites are located adjacent to lake, roads, or other forest types, not all areas located within the threshold distance is suitable murrelet nesting habitat. Using a landscape model of potential murrelet nesting habitat (Raphael et al. 2015, p. 121), we estimated a minimum cumulative total of 256 acres nesting habitat are located within the defined disruption threshold distance of 110 yards from project sites.

Effects of Disturbance to Marbled Murrelets

The Park has included a conservation measure that would restrict disturbance-causing activities from occurring within or adjacent to murrelet nesting habitat during the time periods 2 hours after official sunrise and 2 hours before official sunset during the murrelet nesting season (April 1 to September 23). This restriction reduces the potential to disrupt murrelets during their daily peak activity periods for feeding and incubation exchanges, but it does not ensure that all murrelets will be protected from disturbance under all circumstances. Road repair activities that occur during the mid-day or night hours will likely result in the disruption of adult nesting behaviors, or result in aborted or postponed feedings of nestlings.

Murrelet responses to noise and visual disturbance at nest sites, which have been observed, have primarily been modifications of posture and on-nest behaviors indicating alerting, without flushing or abandoning the nest (Hébert and Golightly 2006, pp. 35-39; Long and Ralph 1998, p. 22). Hébert and Golightly (2006) monitored nesting murrelets exposed to experimental bouts of chainsaw noise and the presence of people hiking on trails in Redwood National and State Parks in northern California. While chainsaws are not directly described in this Action it is likely that they will be used to remove vegetation and chainsaws are a reasonable surrogate for other road construction related noise. Adult and chick responses to chainsaw noise, vehicle traffic, and people walking on forest trails resulted in no flush responses. However, adults exposed to chainsaw noise spent more time with their head raised, and their bill raised up in a posture of alert, vigilant behavior. When undisturbed, adult murrelets spent 95 percent of the time resting or motionless (Hebert and Golightly 2006, pp. 35-39).

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

Adult murrelets typically feed their chicks in the early morning and in the evening. Exposure to loud noise while an adult approaches a nest to provision a chick may cause sufficient disturbance to result in abortion or delay of the feeding. Hamer and Nelson (1998,p. 9) noted that adult murrelets would abort feeding attempts or flush off the nest branch during attempted food deliveries when people on the ground were visible to the birds and within a distance of 15 to 40 m, or occasionally flush when vehicles passed directly under a nest tree. Murrelet chicks appear to be less sensitive to disturbance than adults, and there are no documented instances of a nestling murrelet falling due to sound or visual disturbance, even when researchers were climbing nest trees, handling young, and placing cameras close to young (USFWS 2003, p. 269).

Murrelets have evolved several mechanisms to avoid predation; they have cryptic coloration, are silent around the nest, minimize movement at the nest, and limit incubation exchanges and chick feeding to occur during twilight hours (Nelson 1997, p. 14). Hebert and Golightly (2006) suggest that flushing as a result of a noise disturbance might not provide a benefit compared to the potential risk of exposure to predators. When confronted with the presence of potential predators, murrelets remain on the nest in alert or defensive postures (Hebert and Golightly 2006) and are reluctant to flush unless confronted directly by a large predator such as a raven (Singer et al. 1991).

Based on the best available information concerning murrelet responses to disturbance associated with noise, activity, and human presence, we conclude the following:

- Adult murrelets are most likely to exhibit a flush response while attempting to deliver food to the chick at dawn or dusk. Therefore, disturbance activities that occur in close proximity to occupied nests during dawn or dusk periods can cause adult murrelets to flush and abort a feeding attempt.

- Adult murrelets that are incubating an egg are not likely to flush from noise disturbance alone. The only observations of flushes during incubation involved a direct approach to the nest by a researcher or a predator such as a raven.

- The normal behavior of incubating adults is to rest and remain motionless during the day. Noise disturbance can disrupt this normal behavior by causing the adults to remain vigilant and alert during a time when they are normally resting.

- Murrelet chicks appear to be mostly unaffected by visual or noise disturbance. The greatest risk to murrelet chicks from disturbance is the potential for missed feedings, which occur primarily during dawn and dusk periods, but do occasionally occur during mid-day hours.

Exposure to noise and visual disturbance while an adult approaches a nest to feed a chick may cause sufficient disturbance to result in abortion or delay of the feeding. Noise and visual disturbance has the potential to create an increased likelihood of injury to murrelets in three ways: (1) increasing the risk of predation to adults, eggs, or nestlings; (2) increased energetic expenditure in adults who delay nest establishment activities or have to increase the number foraging trips or time inflight; or, (3) by reducing food consumption by nestlings. We address each of these below.

Potential for Increased Risk of Predation Caused by Disturbance

Murrelets have evolved several mechanisms to avoid predation: they have cryptic coloration, are silent around the nest, minimize movement at the nest, and limit incubation exchanges and chick feeding to occur primarily during twilight hours (Nelson 1997, p. 14). The relationship between human activities and predators, and their potential impact on murrelet nesting success, has been identified as a significant threat to murrelets (Peery and Henry 2010, p. 2414). Losses of eggs and chicks to avian predators have been determined to be an important cause of nest failure

(McShane et al. 2004, p. 4-109). The risk of predation by avian predators appears to be highest in close proximity to forest edges and human activity, where many corvid species (e.g., jays, crows, ravens) are in highest abundance (McShane et al. 2004, p. 4-109).

Murrelets appear to be most sensitive to noise or visual disturbances when they are approaching a nest site or delivering fish to a nestling. There are several documented instances where ground-based activities caused adult murrelets to abort or delay feedings of nestlings, caused adults to divert their flight paths into nesting habitat, or caused murrelets to vacate suitable habitat (Hamer and Nelson 1998, pp. 8-17). These behaviors (e.g., flushing, aborted feedings) can advertise the nest's location, thereby creating an increased risk of predation of the eggs or nestlings while the adults are absent. When an adult is flushed, it can alert a predator to its location and the location of its egg or chick, thereby facilitating predation.

While there is evidence that the risk of nest predation may increase because of noise and visual disturbance, we do not conclude that all murrelet nests exposed to noise and visual disturbance will be predated. The proposed action will result in disturbance to nesting murrelets, one of the potential outcomes of that disturbance is an increased risk of predation. The actual series of events that must happen to lead to predation of an egg or chick (disturbance event → adult murrelet flush or avoidance from nest →predator observation of event → predator detection of nest → consumption of egg or chick) is not an outcome that is reasonably certain to occur as a result of this action. Noise and visual disturbance associated with the proposed action creates the likelihood of injury to murrelets by disrupting normal behavioral patterns (flushing, aborted feedings), which create a risk of predation.

Effects of Disturbance to Adult Marbled Murrelets

Noise and visual disturbance that causes an adult murrelet to abort a prey delivery to the nestling creates a likelihood of injury for the adult through an increased energetics cost, and by exposing the adult to an increased risk of predation. Hull et al. (2001, p. 1036) report that murrelets spend 0.3 to 3.5 hours per day (mean 1.2 ± 0.7 hours per day) commuting to nests during the breeding season. The distance traveled between the nest site and foraging areas ranged from 12 to 102 km, and required substantial energy demands for the adults. Each flight to the nest is energetically costly, increases the risk of predation from avian predators, and detracts from time spent in other activities such as foraging (Hull et al. 2001, p. 1036). Increases in prey capture and delivery efforts by adults result in reduced adult body condition by the end of the breeding season, and increases the predation risks to adults as more trips inland are required (Kuletz 2005, pp. 43-45).

If the adult aborts a single feeding and returns with another prey item that same day, the time the adult spends commuting will increase up to 100 percent, and on those days when the adult makes two feeding round trips, one additional trip will increase commuting time by 50 percent. Ralph et al. (1995, p. 16) state, "Predation on adult murrelets by raptors occurs in transit to nest sites… Given the small number of nest sites that have been monitored, observations of the taking of adult murrelets by predators raise the possibility that this is not a rare event." They proceed to list several observations of raptors killing adult murrelets and of murrelet wings and bones being found in peregrine falcon nests. The significantly increased time airborne as the result of an

aborted feeding creates a likelihood of injury from predation to the adult. As described above, we do not expect exposure to disturbance from this project will result directly in predation mortality, but expect that increased foraging trips as a result of disturbance can increase the risk of predation.

Effects of Artificial Night Lighting on Marbled Murrelets

Although investigations to effects of night lighting on murrelet behavior have not been investigated, we assume that night lighting would allow for construction related activities to proceed for a longer duration in a 24-hour period leading to similar disturbance stressors that occur during daylight hours (noise and human activity). Additionally, artificial light at night has been shown to be attractive to fledgling seabirds such as the threatened Newell's shearwater (*Puffinus auricularis newelli*) and cause disorientation leading to bird strikes and failure of shearwaters to reach marine waters (Telfer et al. 1987, p. 406). The addition of light shielding, such as the downward cast lighting proposed for use this project lead to a 40 percent reduction of bird fallout when it applied on areas of Kauai (Telfer et al. 1987, p. 407). Other methods such as polarization to reduce impacts of artificial light do not seem to be as effective as shielding upward radiating light (Reed 1987, p. 597). Lighting may also cause adult birds returning to the nest to incubate or feed chicks to become disoriented or distracted or avoid returning to the nest for feedings with similar effects to that of noise or visual disturbances, such as avoidance or delayed or reduced feeding. This pattern has been observed in other seabirds such as petrels which experienced heavier predation risk, decreased vocalizations, and decreased colony attendance during naturally brighter lunar conditions at night (Mougeot and Bretagnolle 2000 , pp. 379–382).

The use of artificial lights would create an environment alien to that murrelets have evolved in and creates an additional disturbance stressor. Murrelet fledglings are likely attracted to light, leading to disorientation and potential grounding. However, the light levels used will be low and used only at the end of the nesting season when most murrelets have already left the nest for the marine environment. The extent and intensity from the proposed construction and road rehabilitation is limited to small areas associated with specific construction sites. Conservation measures that limit the use of artificial lighting to after Labor Day (Sept. 5, 2016) will minimize potential exposure of murrelets to artificial lighting. After September 4, less than 5 percent of murrelets are still nesting, so the potential for exposure is substantially reduced (USFWS 2012a, p. 2). While these measures serve to reduce potential impacts of night lighting to murrelets, we conclude that the effects of night lighting are not entirely discountable.

In summary murrelet fledglings are likely attracted to light, leading to disorientation and potential grounding. However, the light levels used will be low and used only at the end of the nesting season when most murrelets have already left the nest for the marine environment.

Effects of Reduced Feedings to Nestlings

Murrelets are most sensitive to noise or visual disturbances when they are approaching a nest site or delivering fish to a nestling. Murrelet nestlings are fed primarily during dawn and dusk periods, but also may be fed throughout the day (Nelson 1997, p.18). Even with morning and

evening timing restrictions in place, murrelets exposed to noise or visual disturbances are susceptible to missed feedings during the day. Nelson and Hamer (1995, p. 62) reported that relatively few feedings take place during the daytime. However, in some areas, 31 to 46 percent of feedings take place during the mid-day hours (USFWS 2012a, p. 5).

Missed feedings can reduce the fitness of nestlings. During chick rearing, adults feed the young 1 to 8 times per day (mean = 3.2 ±1.3 SD) (Nelson and Hamer 1995, p. 61). If we assume an average of 4 feedings per day, a single aborted feeding would constitute a loss of 25 percent of that day's food and water intake for the nestling. Such a loss is considered to be a significant disruption of normal behavior given that "Murrelet chicks grow rapidly compared to most acids, gaining 5 to 15 g/day during the first 9 days after hatching" (Nelson and Hamer 1995, p. 60). With such a fast growth rate and a low average number of daily feedings, missing a single feeding is reasonably certain to disrupt normal growth and create the likelihood of injury by presenting a developmental risk to the chick. Young murrelets that receive multiple daily feedings grow faster and fledge earlier than those with lower provisioning rates. Early fledging helps minimize nest mortality (Nelson and Hamer 1995, p. 66).

The implications of missed feedings due to noise or visual disturbance are significant, because each missed feeding represents a delay in the development of the chick, prolonging the time to fledging and increasing the risk of predation, accidental death from falling off the nest, or abandonment by the adults. If the disturbance at a nest site is prolonged, each successive day of disturbance represents an increasing risk that multiple missed feedings will trigger a significant delay in their growth and development processes, cause permanent stunting, or result in the mortality of a nestling due to malnourishment.

The proposed conservation measure for murrelets that restricts project activities to mid-day and dark hours helps ensure that murrelet nestlings are likely to receive a minimum of one or more feedings during the dawn or dusk hours. We assume that the majority of daily feedings occur during dawn/dusk hours and that these feedings are sufficient to sustain the development of the chick, although the chick may suffer from reduced fitness. Because murrelet nestlings are adapted to inconsistent provisioning by the adults, and since the limiting operating period will allow for some feedings to occur each day without risk of disruption, murrelet nestlings that experience missed feedings due to noise and visual disturbance are expected to still fledge, although fledgling weights may be low, or the development time to fledging may be increased significantly.

Summary of Disturbance Effects

In summary, we are reasonably certain that nesting murrelets are likely to be exposed to noise, visual, and light disturbance as a result of project implementation, and that these disruptions are reasonably certain to increase the risk of a failed nesting attempt due to predation of nestlings, or through reduced fitness of nestlings caused by missed feedings. We anticipate that a cumulative total of up to 256 acres of murrelet nesting habitat in the action area would be subjected to noise and visual disturbance during project implementation, over the course of three construction seasons (2016, 2017, and 2018). Individual areas of murrelet habitat exposed to noise and visual disturbance range from 7.8 acres up to 12 acres depending on the size of individual road repair

locations. The Park estimated that the Project may take up to 3 years to fully implement, but the overall duration of project implementation is not expected to change the intensity of the effects or the number of individuals affected because each repair location would be repaired once, regardless of the time it takes to complete all proposed sites in the project, for a cumulative total of 256 acres exposed to disturbance.

Although there have been a number of murrelet occupancy detections within the action area, there are no appropriate data or analyses from which to estimate the number of murrelets that would be present in the action area, or within the disruption distances we use to evaluate exposure to disturbance effects. The information we do have indicates the murrelet occupancy has been documented in within the action area. Accordingly, we are reasonably certain that low numbers of murrelets will be exposed to noise and visual disturbance during the proposed action. For this analysis, we use acres of nesting habitat disturbed as a habitat surrogate for the number of individual murrelets likely to be exposed.

CUMULATIVE EFFECTS: Marbled Murrelet

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 ESA.

The project action area surrounding Lake Crescent project action area is completely surrounded by Park Boundaries with the exception of some small private inholdings along the north shore of the lake. There areas containing small parcels of private lands and larger extents of state owned timberlands adjacent to the Park boundary to the north. Non-Federal lands in the area are managed primarily for timber production and as private residences, but almost all forest that was potential murrelet nesting habitat on these lands has been previously harvested. Private timber harvest in the area must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Administrative Code with respect to the Washington Forest Practices Rules (WAC 222).

The Service completed a formal consultation on the Washington State Forest Practices Rules in 2006 and anticipated that essentially all potential murrelet habitat located on private lands that are not associated with occupied sites or other protected areas will eventually be lost due to timber harvest (USFWS 2006, p. 477). Although the Service determined that ongoing forest practices on private lands "may affect, and is likely to adversely affect" murrelets, we concluded that these effects were not likely to jeopardize the continued existence of murrelets (USFWS 2006, p. 482). Because these effects have already been addressed through section 7 consultation, they are not considered cumulative effects.

INTEGRATION AND SYNTHESIS OF EFFECTS: Marbled Murrelet

The Integration and Synthesis section is the final step in assessing the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action and the cumulative effects to the status of the species and critical habitat, and the environmental baseline, to formulate our biological opinion as to whether the proposed action is likely to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated critical habitat for the conservation of the species.

Overview of Marbled Murrelet Population Demography and Habitat Relationships

Murrelets are long-lived birds, with high adult survival, low annual fecundity, and delayed maturity (McShane et al. 2004, p. 3-34). It may take a breeding pair several successive years of nesting attempts to replace themselves in the population. Murrelet demography studies and population viability modeling indicate that murrelet populations are most sensitive to changes in adult survival and fecundity (reproductive success) (McShane et al. 2004, pp. 3-53 to 3-58). Although adult annual survival rates are relatively high in murrelets (estimated at 83 to 92 percent), it is likely that recruitment rates throughout the species listed range are too low to reverse the current population decline.

The Service recently convened a Recovery Implementation Team which concluded that the primary cause of the continued population decline is sustained low recruitment. Sustained low recruitment can be caused by nest failure, low numbers of nesting attempts, and/or low juvenile survival rates due to 1) terrestrial habitat loss, 2) nest predation, 3) changes in marine forage base which reduce prey resources, and 4) cumulative effects of multiple smaller impacts.

Juvenile ratios, as an index of nest success, indicate that fecundity is well below the level needed to maintain current murrelet abundance. In California (Conservation Zones 4, 5 and 6), the leading causes of low fecundity are low marine food availability in some years which prevents murrelets from nesting, and in years when many murrelets nested nest predation was very high (Peery et al. 2004, p. 1095). We expect these factors may be the leading causes of low fecundity in Washington as well (Conservation Zones 1 and 2).

Recent monitoring efforts in Washington indicated that only 20 percent of monitored murrelet nesting attempts were successful, and only a small portion of the 158 tagged adult birds actually attempted to nest (13 percent) (Raphael and Bloxton 2009, p. 165). The authors conclude that the apparent low nesting rate coupled with low nesting success suggests that the murrelet populations in Conservation Zones 1 and 2 do not produce enough young to support a stable population (Raphael and Bloxton 2009, p. 165). The low number of adults attempting to nest is not unique to Washington. Some researchers suspect that the portion of non-breeding adults in murrelet populations can range from about 5 percent to 70 percent, depending on the year, but most population modeling studies suggest a range of 5 to 20 percent (McShane et al. 2004, p. 3-5).

The rangewide population estimate for the NWFP area in 2013 was 19,662 murrelets (95 percent CI: 15,398 to 23,927) (Falxa and Raphael 2015, p. 41). Raphael et al. (2011, p. 44) showed a strong positive association between regional murrelet populations and total suitable habitat at the scale of the five Conservation Zones within the NWFP area. At the scale of the entire NWFP (including non-Federal lands), murrelet nesting habitat has declined from 3.81 million acres in 1994 to 2.23 million acres in 2012, with a loss of over 13.3 of suitable nesting habitat percent in Washington alone (Falxa et al. 2015 p. 89).

Surveys from 2001 to 2010 indicated that murrelet populations throughout the listed range declined at a rate of 3.7 percent per year (Miller et al. 2012, p. 771), but the statistical power of this trend was no longer apparent at the range-wide scale with increasing densities of murrelets documented in 2000 to 2013 period (Falxa and Raphael 2015, p. 1). The Zone level results observed strong evidence of linear population declines in Conservation Zones 1 and 2 with an approximately 5 percent annual rate of decline in both zones (Falxa et al. 2015, p. 3). At the Washington State scale a strong evidence was found for a declining linear trend (4.6-percent decline per year; 95-percent confidence interval: −7.5 to −1.5 percent) (Falxa and Raphael 2015, p. 1). While the direct causes for the population declines are unknown, potential factors include the loss of nesting habitat, including cumulative and time-lag effects of habitat losses over the past 20 years (an individual murrelet's potential lifespan), changes in the marine environment that reduce the availability or quality of prey, increased densities of nest predators, and emigration (Miller et al. 2012, p. 778).

The population decline is most severe in the northern part of the listed range, particularly in Conservation Zones 1 (Puget Sound/Strait of Juan de Fuca) and 2 (Coastal Washington). The Zone level results observed strong evidence of linear population declines in Conservation Zones 1 and 2, with an approximately 5 percent annual rate of decline in both zones (Falxa et al. 2015, p. 3).

Although there are strong correlations between the amount and distribution of nesting habitat and the total numbers of murrelets at a regional scale (Raphael et al. 2011, p. 45), corresponding data are not available to allow us to accurately enumerate the number or density of murrelets at the scale of individual stands of murrelet nesting habitat. Raphael et al. (2002, p. 340) used radar survey data to estimate an average density of more than 370 acres of nesting habitat per murrelet detected in their study on the Olympic Peninsula, indicating very low densities of murrelets at a regional scale. At the watershed scale, murrelet nest densities estimated from radar range from 0.005 to 0.083 nests per acre (1 nest per 12 to 200 acres of nesting habitat), while nest densities at the nest patch scale estimated from tree climbing efforts have ranged from 0.05 to 1.7 per acre (1 nest per 1.7 to 20 acres of nesting habitat) (McShane et al. 2004, p. 4-60). Given the tremendous variability in the density of murrelets at inland nest sites, we cannot accurately correlate direct habitat effects to the actual number of murrelets that may be affected by a given action. However, we are able to reliably quantify habitat effects, and we can reasonably infer how these effects may influence murrelet population dynamics at both local and regional scales.

To conclude, there are several key facts that we draw upon in our analysis of effects to murrelet populations:

- Adult murrelets are long-lived, have high annual survival rates, and have very low reproductive rates. In any given year, a significant portion of the adult population does not nest or attempt to nest.

- Reproductive success (fecundity) is very low, and is currently insufficient to sustain a stable population. Nest predation and poor marine foraging conditions are implicated as primary causes.

- Murrelet density at inland nesting sites is highly variable. At a regional scale, murrelets occupy nesting habitat at very low densities (100s of acres of nesting habitat per murrelet) but densities can be as high as one nest per 12 acres at a watershed scale and one nest per 1.7 acres at a nest patch scale. Loss of nesting habitat continues to be an important factor limiting murrelet recovery at a regional scale.

In summary, the species' inherently low annual reproductive potential, coupled with a suite of environmental stressors that limit the species productivity, leads us to conclude that the species will continue to experience local and rangewide population declines in the foreseeable future. The survival and recovery of this species depends upon improving reproductive success.

Summary of Adverse Effects to Marbled Murrelets

We anticipate that the murrelets associated with 256 acres of nesting habitat located adjacent to the proposed road repair locations are reasonably certain to be exposed noise and visual disturbance effects. Murrelet responses to disturbance include delay in or avoidance of nest establishment, flushing from a nest or branch within nesting habitat, aborted or delayed feeding of juveniles, or increased vigilance/alert behaviors at nest sites with implications for reduced individual fitness and reduced nesting success. These behavioral disruptions are reasonably certain to occur and create situations where the likelihood of injury increases the opportunity for predation, reduced fitness of nestlings as a result of missed feedings, and/or increased energetic costs to adults that must make additional foraging trips.

We do not expect that noise and visual disturbance will directly result in nest failure, but acknowledge that disturbance creates an increased likelihood of injury that can indirectly result in nest failure due to predation or reduced fitness of individuals. The Park has incorporated a daily operating restriction that will avoid project activities during the murrelets daily peak activity periods during dawn and dusk hours until Labor Day. This daily restriction reduces, but does not eliminate, the potential for adverse disturbance effects or disrupted feeding attempts during mid-day hours. Additionally there is the potential for increased adverse disturbance during night work over a roughly three week period after Labor Day and prior to September 23 of each calendar year due to increased artificial light and related noise and visual disturbance.

Effects to Marbled Murrelet Numbers and Reproduction

In the above analysis, we estimated that murrelets associated with a total of approximately 256 acres of murrelet nesting habitat will be exposed to disturbance effects during the proposed project. This is the total habitat acres dispersed across the Project area. Habitat exposed to project effects represents a small fraction of the total available murrelet habitat in the Park, and available murrelet habitat in Conservation Zones 1 and near 2. Based on location of the action area in Conservation Zones 1 and near Conservation Zone 2, and the limited area affected by the proposed action, we anticipate very few murrelets in each Conservation Zone will be affected.

We do not expect disturbance effects to result in direct nest failure. However, if we assumed that the project did result in nest failure of one or two nestlings due to nest abandonment, the scale of the effect on murrelet numbers and reproduction would be so small as to be immeasurable against the baseline of murrelet population trends. Although adult murrelets have high annual survival rates, murrelets suffer high rates of nest failure due to nest predation and starvation of young, even in pristine habitats located far from human disturbance. The current murrelet population estimate for Conservation Zones 1 and 2 is approximately 7,500 murrelets. A potential loss of one or two nestlings is not anticipated to appreciably reduce the likelihood of survival and recovery at the scale of Conservation Zone 1 or rangewide. This is due to the fact that the total number of adult murrelets that attempt to nest in any given year is variable, and the overall nest success rates are variable and generally very low. Considering the variable response of murrelets to noise and visual disturbance (i.e., most nests exposed to the disturbance effects are not expected to fail) and limited areas exposed to, the incremental loss of reproduction anticipated is not expected to increase the present rates of observed population declines in Conservation Zones 1 and 2 or rangewide.

The effects of the proposed action will not appreciably reduce the likelihood of persistence through a reduction in murrelet numbers or reproduction at the scale of the action area or any larger scale because: 1) none of the nests exposed to disturbance are reasonably certain to fail; 2) the area exposed to disturbance is limited (256 acres), and corresponds to very low numbers of murrelets that are likely to be exposed to disturbance effects relative to the available nesting habitat in the action area; and, 3) no direct mortality of adult murrelets is anticipated, so there would be no reduction in the current population of breeding adults.

Marbled Murrelet Distribution

We do not expect that the proposed action would affect the distribution of murrelets within either the action area or Conservation Zones 1 and 2 because the anticipated disturbance to occupied stands would be temporary, and there would be no loss of murrelet nesting habitat. The essential conservation role of the action area and the Park to provide for murrelet survival and recovery would not be reduced or diminished by this action. Therefore, the proposed action is not expected to affect the distribution of murrelets in the action area, Conservation Zones 1 and 2, or within the listed range of the species.

Given the above analysis, we conclude that the adverse effects to murrelets that would result from the proposed action, and any cumulative effects, are not likely to appreciably reduce the likelihood of survival and recovery of the murrelet in the wild by reducing murrelet numbers, reproduction, or distribution at the scale of the Park, Conservation Zones 1 and 2, or within the listed range of the species.

CONCLUSION: **Marbled Murrelet**

After reviewing the current status of the murrelet, 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 Olympic National Park U.S. Highway 101 Lake Crescent and East Beach Road Rehabilitation Project, as proposed in Alternative 3, the preferred of the EA, is not likely to jeopardize the continued existence of the murrelet. While critical habitat for the murrelet has been designated, it does not occur within the action area of this project. Therefore, the proposed action is not likely to destroy or adversely modify designated critical habitat for the murrelet.

INCIDENTAL TAKE STATEMENT

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

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

AMOUNT OR EXTENT OF TAKE

Marbled Murrelet

In the accompanying Biological Opinion, we determined that the proposed action will result in incidental take of murrelets. The Service anticipates incidental take of murrelets associated with approximately 256 acres of nesting habitat that is likely to be exposed to significant noise and visual disturbance associated with project implementation during the murrelet nesting season in April 1 through September 23 over no more than 4 years. The take is in the form of harassment.

Murrelets are cryptic, nest locations are rarely located, and available data suggest a patchy and inconsistent distribution in the action area. For these reasons, the Service has used the quantity of suitable murrelet nesting habitat that is reasonably certain to be occupied as a surrogate measure of take. These habitat areas are the best available surrogate measure of the extent of harassment.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-711), if such take is in compliance with the terms and conditions specified herein.

EFFECT OF THE TAKE

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

REASONABLE AND PRUDENT MEASURES

The conservation measures negotiated in cooperation with the Service and included as part of the *Description of the Proposed Action* constitute all of the reasonable measures necessary to minimize the impacts of incidental take. On that basis, only one Reasonable and Prudent Measures is included in this Incidental Take Statement.

1. Monitor and report incidental take caused by exposure to temporary, construction-related sources of sound and visual disturbance.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, the Park Service must comply with the following terms and conditions, which implement the reasonable and prudent measure (RPM), described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The following terms and conditions are required for the implementation of RPM 1:

1. When developing final plans for construction, the Park shall include enforceable contract specifications to ensure full and successful implementation of the agreed-upon conservation measures.

2. The Park shall prepare a schedule in advance of each year's construction activities. The schedule shall outline and communicate seasonal and day/night work timing restrictions, with reference to specific work locations, staging locations, and/or roadway sections. The Park shall provide the schedule to the selected Contractor(s) and work cooperatively to refine and adaptively manage implementation of the schedule, including contingencies. The Park shall provide a copy of each year's construction schedule to the Service at their earliest convenience, but no later than June 1.

3. The Park shall conduct a field review of work and staging locations in advance of each year's construction activities. The Park shall assess the limits of construction, and identify and confirm unavoidable impacts to mature vegetation, with reference to specific locations and/or roadway sections. The Park shall plan, cooperatively refine with Contractor(s) input, and adaptively manage the implementation of best management practices (BMPs) designed to avoid and minimize impacts to mature trees and stands providing suitable habitat.

4. In the project description the Park states that habitat within the project area has been surveyed for trees with suitable murrelet nest platforms. If during the project the areas impacted should be for any reason altered and suitable nest trees must be removed the Park shall notify the Service at their earliest convenience to manage clearing and other work activities to avoid any possibility of nest destruction. The Park shall coordinate with the Service to positively confirm the absence of nesting murrelets and/or postpone clearing until after the murrelet nesting season.

5. The Park shall prepare, and provide to the Service no later than December 15, a summary of each year's construction activities. The summary shall describe implementation of the seasonal and day/night work timing restrictions, schedule/construction contingencies and adaptive management, current year survey findings, and the implementation of BMPs designed to avoid and minimize impacts to mature trees and stands providing suitable habitat.

6. All materials for submittal to the Service shall be sent to the Washington Fish and Wildlife Office's Consultation and Conservation Planning Division (Attn: Manager, Forest Resources Branch).

We expect that the amount or extent of incidental take described above will not be exceeded as a result of the proposed action. The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs provided. The Park must provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs.

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

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service offers the following non-binding conservation recommendation to the Park Service to promote the recovery of federally listed species and their habitats:

1. Minimize or eliminate night work during the nesting season of the murrelet April 1 through September 23.

2. To the greatest extent possible within suitable murrelet habitat, do not allow day work in the same area where night work occurred. Night construction work zones should be restricted to those areas a distance of 100 meters or greater from day construction work zones.

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

REINITIATION NOTICE

This concludes formal consultation on the Project, as outlined in the March, 2016, Biological Assessments and requests for consultation under section 7 or the ESA. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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APPENDIX A
STATUS OF THE SPECIES: Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratus*) (murrelet) was listed by the U.S. Fish and Wildlife Service (Service) as a threatened species in Washington, Oregon, and California in 1992. The primary reasons for listing included extensive loss and fragmentation of the older-age forests that serve as nesting habitat for murrelets, and human-induced mortality in the marine environment from gillnets and oil spills (57 FR 45328 [Oct. 1, 1992]). Although some threats such as gillnet mortality and loss of nesting habitat on Federal lands have been reduced since the 1992 listing, the primary threats to species persistence continue (75 FR 3424 [Jan. 21, 2010]).

Life History

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

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

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

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

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

Murrelets in the Marine Environment

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

Breeding Season

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

Winter Range

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

Foraging and Diet

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

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

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

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

Murrelets in the Terrestrial Environment

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

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

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

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

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

Distribution

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

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

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

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

Distribution of Nesting Habitat

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

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

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

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

Population Status

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

Population Status and Trends

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

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

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

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

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

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

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

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

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

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

Factors Influencing Population Trends

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

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

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

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

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

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

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

Population Models

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

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

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

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

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

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

Reproduction

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

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

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

[1] The juvenile ratio (**Ŕ**) for murrelets is derived from the relative abundance of hatch-year (HY; 0-1 yr-old) to after-hatch-year (AHY; 1+ yr-old) birds (Beissinger and Peery 2007, p. 297) and is calculated from marine survey data.
[2] Nest success here is defined by the annual number of known hatchlings departing from the nest (fledging) divided by the number of nest starts.

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

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

Summary: Murrelet Abundance, Distribution, Trend, and Reproduction

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

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

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

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

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

Threats to Murrelet Survival and Recovery

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

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

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

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

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

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

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

Climate Change

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

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

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

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

Conservation Needs of the Species

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

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

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

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

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

Recovery Plan

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

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

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

Long-term conservation needs identified in the Plan include:

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

Recovery Zones in Washington

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

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

Summary

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

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

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

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

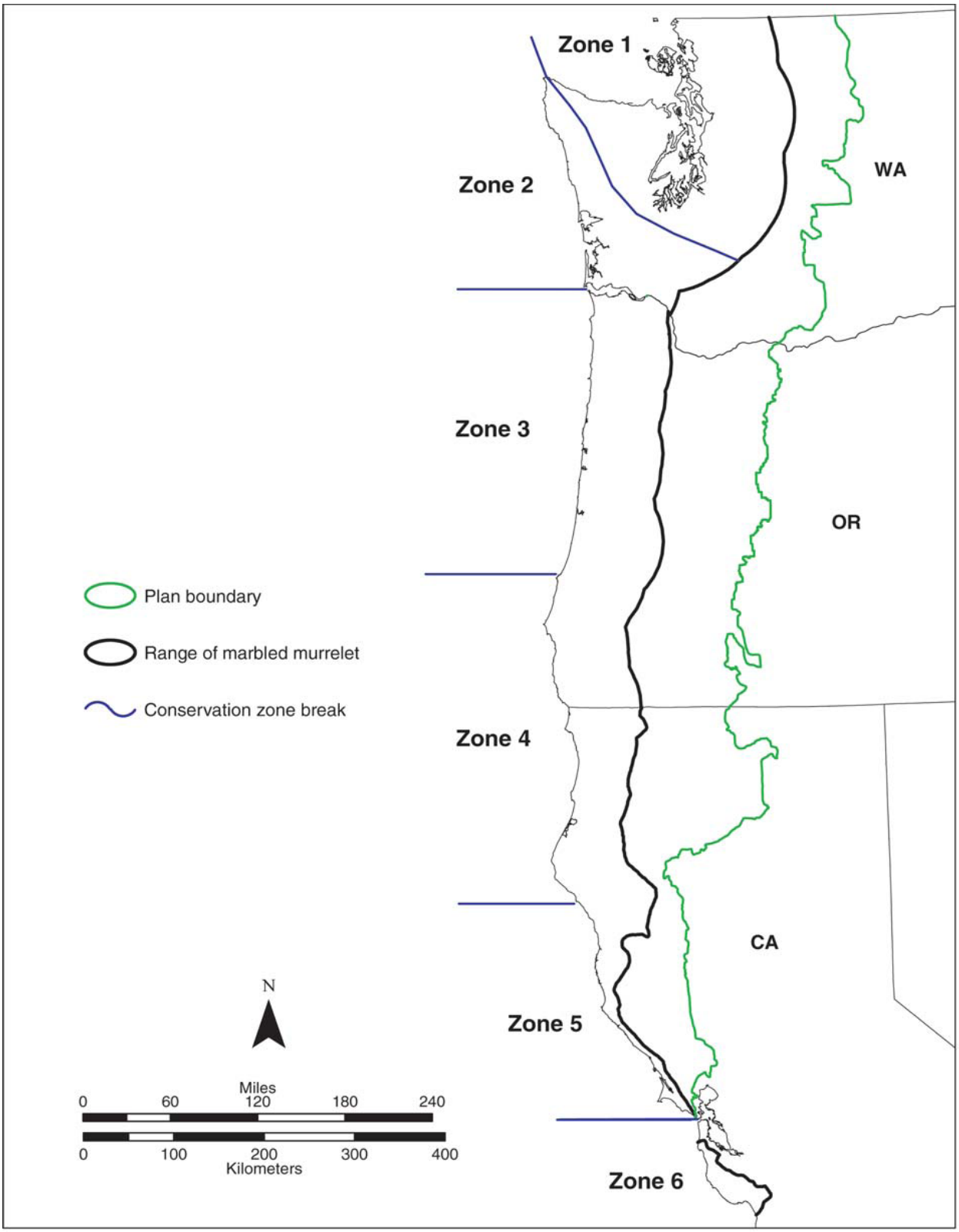

Figure 1. The six geographic areas identified as Conservation Zones in the recovery plan for the marbled murrelet (USFWS 1997). Note: "Plan boundary" refers to the Northwest Forest Plan. Figure adapted from Huff et al. (2006, p. 6).

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