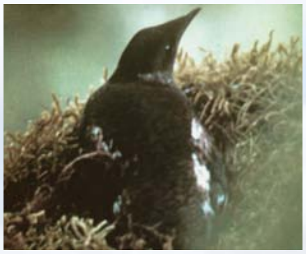
Long-Term Conservation Strategy for the Marbled Murrelet

Draft | ENVIRONMENTAL IMPACT STATEMENT





December 2016

U.S. FISH & WILDLIFE SERVICE

WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES

Murrelet photos courtesy www.HamerEnvironmental.com (left) and National Park Service (right)

December 2016

Dear Interested Party,

The Washington Department of Natural Resources (DNR) is developing a long-term conservation strategy for the marbled murrelet. Once a long-term strategy is approved by the Board of Natural Resources, DNR intends to amend the State Trust Lands Habitat Conservation Plan (1997 HCP) and apply for a new incidental take permit for the marbled murrelet under the Endangered Species Act (ESA). A long-term strategy will replace the current, interim strategy for the marbled murrelet, but it is not intended to change any of the other conservation strategies being implemented under the 1997 HCP.

The marbled murrelet is federally listed as a threatened species under the Endangered Species Act. These small, fast-flying seabirds spend most of their lives in the marine environment, but nest inland on large limbs of Douglas fir and western hemlock trees in western Washington. Marbled murrelet population decline in Washington has been linked to the loss of inland nesting habitat, as well as threats in the marine environment. Uncertainty about the location and extent of important nesting habitat on state trust lands has created challenges for DNR as we conduct forest management activities and implement the current HCP. A long-term strategy is intended to better identify strategically important murrelet nesting habitat on DNR-managed lands, provide long-term certainty for timber harvest and other management activities on forested state trust lands, and contribute to long-term conservation of the species.

This Draft Environmental Impact Statement (DEIS) evaluates five alternative long-term strategies along with a no action alternative (the current, interim strategy). Each action alternative provides a unique approach to murrelet habitat conservation, designating varying amounts of habitat for conservation and applying conservation measures to ensure long-term protection of forestlands important to the murrelet.

This document was produced collaboratively with the U.S. Fish and Wildlife Service and is intended to satisfy the environmental review requirements of both the State Environmental Policy Act (SEPA) and National Environmental Policy Act (NEPA).

We invite you to provide comment on this DEIS through March 1, 2017. Further information is posted at www.dnr.wa.gov/mmltcs.

Thank you for your interest in habitat conservation for the marbled murrelet and the sustainable management of state trust lands.

Sincerely,

Peter Goldmark
Commissioner of Public Lands

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DRAFT

Environmental Impact Statement

on a

Long-Term Conservation Strategy for the Marbled Murrelet

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Published:

Olympia, Washington
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Cover Sheet/Fact Sheet

Title: Draft Environmental Impact Statement on a Long-term Conservation Strategy for the Marbled Murrelet

Description of Proposal: This is a joint Draft Environmental Impact Statement between U.S. Fish and Wildlife Service and Washington State Department of Natural Resources to satisfy both the National Environmental Policy Act and the State Environmental Policy Act. This proposal involves amending the Washington State Department of Natural Resources 1997 *Habitat Conservation Plan for State Trust Lands* with a long-term conservation strategy for the marbled murrelet. Six alternatives, including a no action alternative, are analyzed. There is not a preferred alternative.

Proponent: Washington Department of Natural Resources

Legal Mandate: Endangered Species Act of 1973; National Environmental Policy Act; State Environmental Policy Act

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U.S. Fish and Wildlife Service

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Date of Issue of DEIS: December 2, 2016

Comment Period:

The comment period for this Draft EIS is **December 2, 2016, through March 1, 2017.** Comments are due to the SEPA Center no later than 5:00 PM on Wednesday, March 1, 2017.

Public Meetings:

January 10, 2017 (6-8 p.m.)
NW Region Office – NW Conference Center
919 N Township
Sedro Woolley, WA 98284

January 12, 2017 (6-8 p.m.)
Whitman Middle School – Auditorium
9201 15th Ave NW
Seattle, WA 98117

January 17, 2017 (6-8 p.m.)
Port Angeles High School – Commons/Lunch Room
304 E Park Ave
Port Angeles, WA 98362

January 19, 2017 (6-8 p.m.)
Julius A Wendt Elementary School – Multipurpose Room
265 S 3rd St
Cathlamet, WA 98612

January 24, 2017 (2-3 p.m.)
Webinar – link will be available at:
www.dnr.wa.gov/mmltcs

Anticipated Issuance of Final EIS: unknown

Notice of Availability:

This DEIS is posted online at:
www.dnr.wa.gov/mmltcs

Copies will be sent to: the Board of Natural Resources; affected local government planning departments (city and county); affected Tribes; all state and federal agencies with jurisdiction; academia; Washington newspapers; libraries; and other interested parties.

A limited number of additional print copies and computer print CDs will be available at no charge. After these are distributed, copies will be available for the cost of printing or CD production. Requests can be sent to the DNR contact address.

Location of supporting documents:

Supporting documents for this DEIS including the 1997 *Habitat Conservation Plan for State Trust Lands* can be found online at www.dnr.wa.gov, and are available for review at the DNR SEPA Center at 1111 Washington Street SE in Olympia, Washington.

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(These appendices are provided on a CD in the back cover of the DEIS and on the DNR website.)

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SUMMARY

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Summary

This draft environmental impact statement (DEIS) is a joint document produced by the Washington Department of Natural Resources (DNR) and the U.S. Fish and Wildlife Service (USFWS). This document is intended to satisfy the requirements of the National Environmental Policy Act (NEPA) and the Washington State Environmental Policy Act (SEPA) for environmental review. The proposed action under review is an amendment to DNR's 1997 *State Trust Lands Habitat Conservation Plan* (1997 HCP). The amendment will replace the interim conservation strategy for the marbled murrelet (*Brachyramphus marmoratus*) with a long-term conservation strategy. The amendment is limited to this subject and does not change other conservation strategies of the 1997 HCP.

Need, Purpose, and Objectives

Need: DNR needs to obtain long-term certainty for timber harvest and other management activities on forested state trust lands, consistent with commitments in the HCP and DNR's fiduciary responsibility to the trust beneficiaries as defined by law.[1] USFWS needs to provide for conservation of the marbled murrelet by ensuring that the HCP meets permit issuance criteria under the Endangered Species Act (ESA) Section 10(a)(1)(B).

Purpose: The purpose of the proposed action is to develop a long-term conservation strategy for marbled murrelets on forested state trust lands in the six west-side planning units, subject to DNR's fiduciary responsibility to the trust beneficiaries as defined by law, and USFWS's responsibilities under the ESA, which achieves all of the following objectives:

- **Objective #1, Trust Mandate**: Generate revenue and other benefits for each trust by meeting DNR's trust management responsibilities. Those responsibilities include making state trust lands productive, preserving the corpus of the trust, exercising reasonable care and skill in managing the trust, acting prudently with respect to trust assets, acting with undivided loyalty to trust beneficiaries, and acting impartially with respect to current and future trust beneficiaries.
- **Objective #2, Marbled Murrelet Habitat:** Provide forest conditions in strategic locations on forested trust lands that minimize and mitigate incidental take of marbled murrelets resulting from DNR's forest management activities. In accomplishing this objective, we expect to make a significant contribution to maintaining and protecting marbled murrelet populations.
- **Objective #3, Active Management:** Promote active, innovative, and sustainable management on state trust lands.
- **Objective #4, Operational Flexibility**: Provide operational flexibility to respond to new information and site-specific conditions.

[1] Trust duties are discussed in more detail in Chapter 1, Section 1.2.

- **Objective #5, Implementation Certainty**: Adopt feasible, practical, and cost-effective actions that are likely to be successful and can be sustained throughout the life of the HCP.

The Alternatives

Six alternatives are analyzed in this DEIS, including a no action alternative. There is not a preferred alternative expressed in the DEIS. These alternatives represent a range of approaches to long-term marbled murrelet habitat conservation. The alternatives differ in the amount and location of DNR-managed forestland designated for long-term conservation and also include a combination of conservation measures proposed to protect marbled murrelet habitat. These forestlands all occur within 55 miles of marine waters. This 55-mile line is the same as was used in the Northwest Forest Plan (USDA 1994) and is used by USFWS as an estimate of the inland range of the marbled murrelet in Washington. The total acreage of DNR-managed lands within this analysis area is approximately 1.37 million acres.

Acres proposed for continued conservation include lands already protected as long-term forest cover by DNR, such as old-growth forests, high-quality owl habitat, riparian areas, natural areas, and other conservation commitments of the 1997 HCP and *Policy for Sustainable Forests*. These areas provide conservation benefits to the marbled murrelet either by supplying current and/or future nesting habitat or by providing security to that habitat from predation, disturbance, and other threats. The alternatives also delineate additional forestlands with specific importance for marbled murrelet conservation. The range of acres proposed for conservation are summarized in Table S-1.

Table S-1. Summary of Conservation Acres Proposed Under Each Alternative (Alt.)

	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Acres of existing conservation that may provide benefits to marbled murrelets depending on forest condition	583,000	583,000	583,000	583,000	583,000	583,000
Acres of additional, marbled murrelet-specific conservation	37,000	10,000	53,000	51,000	57,000	151,000
Total approximate acres of long-term conservation (long-term forest cover)	620,000	593,000	636,000	634,000	640,000	734,000

All of the alternatives release certain amounts of marbled murrelet habitat for timber harvest. These acres are not part of the conservation acres shown in Table S-1 and will continue to be managed under the 1997 HCP and *Policy for Sustainable Forests*. The total acres released is shown in Table S-2.

Table S-2. Estimated Acres of Marbled Murrelet Habitat Released for Harvest, by Alternative

	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Estimated marbled murrelet habitat released	36,000	49,000	35,000	42,000	34,000	25,000

■ Marbled murrelet conservation areas

Marbled murrelet conservation areas include all of the occupied sites currently protected under the interim strategy, additional occupied site acreage based on recommendations from the 2008 *Recommendations and Supporting Analysis of Conservation Opportunities for the Marbled Murrelet Long-Term Conservation Strategy* (Science Team Report), and a variety of areas proposed specifically for strategic marbled murrelet conservation under different alternatives. These proposed marbled murrelet conservation areas are summarized in Table S-3 and mapped in Appendix F.

Table S-3. Summary of Marbled Murrelet-Specific Conservation Areas Proposed Under Each Alternative

Alternative	Conservation areas
A (no action)	• Existing occupied sites (not including those recommended for addition by the Science Team Report) • Occupied site buffers (100 meters) • Habitat identified under the interim strategy
B	• Occupied sites (including those delineated in the Science Team Report)
C	• Occupied sites (including those delineated in the Science Team Report) • Occupied site buffers (100 meters, except in the Olympic Experimental State Forest (OESF), where sites 200 acres or larger have 50-meter buffers) • Special habitat areas: discrete areas of marbled murrelet habitat and adjacent security forest within which active management and other land uses are restricted • Emphasis areas: enhanced (0.5-mile) buffers on occupied sites within the emphasis area, current and future marbled murrelet habitat, and areas of active management • Isolated stands of high-quality marbled murrelet habitat
D	• Occupied sites (including those delineated in the Science Team Report) • Occupied site buffers (100 meters, except in OESF, where sites 200 acres or larger have 50-meter buffers) • Special habitat areas: discrete areas of marbled murrelet habitat and adjacent security forest within which active management and other land uses are restricted

Alternative	Conservation areas
E	• Occupied sites (including those delineated in the Science Team Report) • Occupied site buffers (100 meters, except in OESF, where sites 200 acres or larger have 50-meter buffers) • Emphasis areas (as described under Alternative C) where both habitat protection and active management area are allowed • Special habitat areas where active management and other land uses are restricted. There are fewer acres of special habitat areas proposed under Alternative E than under Alternative D • Isolated stands of high-quality marbled murrelet habitat
F	• Occupied sites (including those delineated in the Science Team Report) • Occupied site buffers (100 meters) • Marbled Murrelet Management Areas (MMMAs) as delineated in the Science Team Report and additional MMMAs in the North Puget planning unit; these areas allow some management activities consistent with habitat development and protection

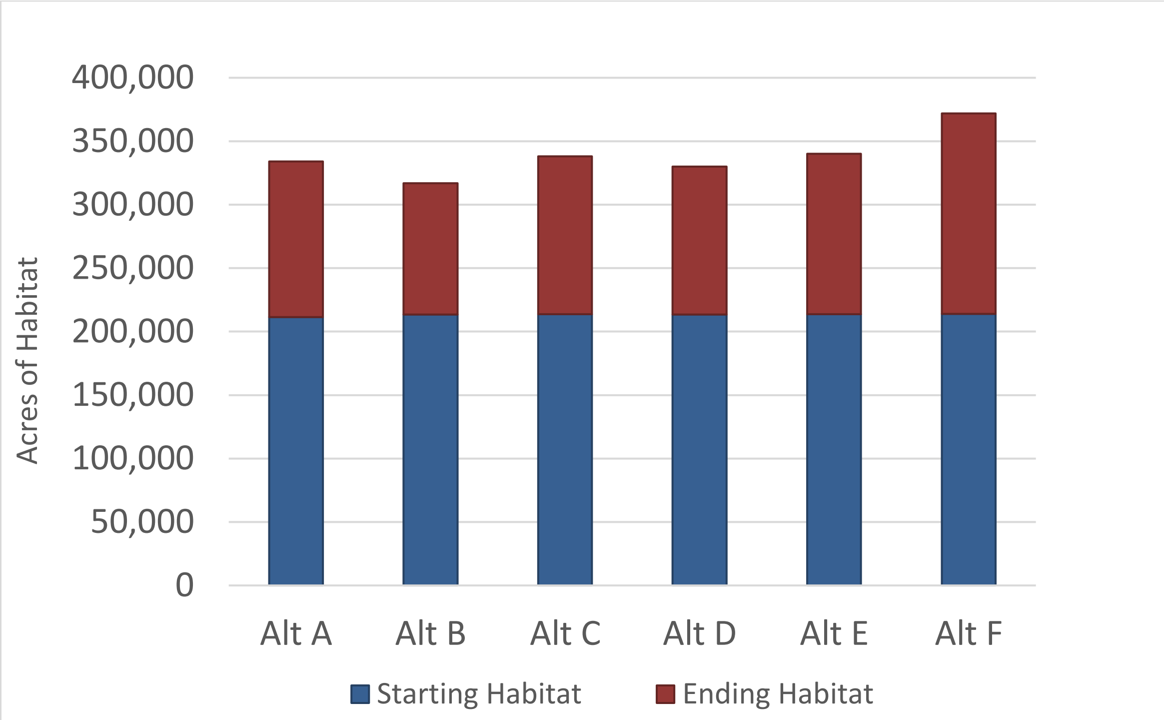
These conservation areas are geographically distributed throughout the analysis area and focus on the protection of current habitat and development of future habitat.

Alternatives C through F focus new conservation in southwest Washington, protecting more marbled murrelet habitat there than is protected under the no action alternative. Alternative F protects the most habitat in southwest Washington (and throughout the analysis area), while Alternative B protects significantly less habitat than the no action alternative.

Alternatives C through F also emphasize murrelet conservation in important areas west of National Forest lands in the North Puget HCP planning unit (within close proximity to marine waters). Alternatives C, D, and E provide more murrelet conservation near the Strait of Juan de Fuca compared with the other alternatives.

Under all alternatives, marbled murrelet habitat within these proposed conservation areas and throughout long-term forest cover is expected to increase over the life of the long-term strategy (through 2067), as illustrated in Figure S-1.

Figure S-1. Growth of Habitat Through Time, by Alternative (acres not adjusted for habitat quality)



New Conservation Measures

The action alternatives also establish new conservation measures that would be added to the 1997 HCP to minimize impacts from new or expanded forest management and land use activities within marbled murrelet habitat. These measures are based on current understanding about activities that could disturb nesting murrelets and/or result in habitat loss. The measures limit harvest within long-term forest cover, limit thinning activities within and near habitat, prohibit or limit road construction in marbled murrelet conservation areas, apply daily timing restrictions to potentially disturbing management activities such as road construction or aerial operations during nesting season, limit development of new or expanded recreational facilities in marbled murrelet conservation areas, and minimize the impacts of other non-timber harvest activities.

How the Proposed Long-Term Strategy Relates to Other DNR Conservation Commitments

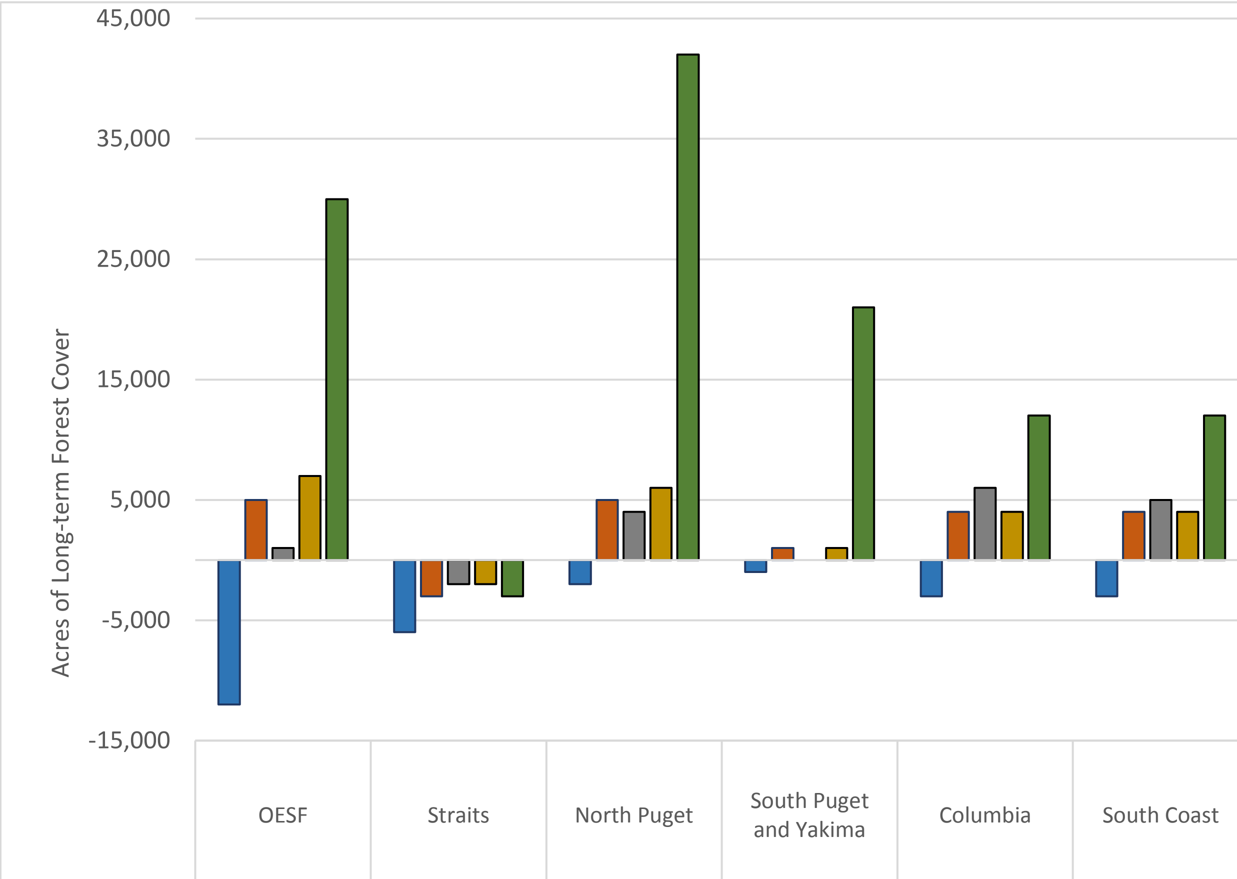
Many of the existing 1997 HCP conservation strategies provide conservation benefits to the marbled murrelet. These include riparian strategies, old-growth strategies, and northern spotted owl strategies. In addition, the *Policy for Sustainable Forests* provides for conservation of forestland for wildlife diversity, protecting genetic resources and uncommon habitats, and other specific conservation objectives. The action alternatives are intended to work in concert with these strategies and policies. Where proposed conservation areas would overlap areas conserved for other reasons (for example, an occupied site within a riparian management zone), the most protective management policy or measure would apply.

Summary of Potential Impacts to Elements of the Environment

Impacts evaluated in this DEIS relate primarily to the acres of long-term forest cover provided by each action alternative and the proposed conservation measures (for example, measures proposed for thinning, recreation, and road construction).

Compared with the no action alternative, Alternative B would decrease the area of long-term forest cover by 27,000 acres (approximately 2 percent of DNR-managed forestland in the analysis area). Alternatives C through E would increase long-term forest cover by 14,000 to 20,000 acres, and Alternative F would increase this area by 114,000 acres. Figure S-2 provides a summary of how these acres change from Alternative A (no action), reported by geographic planning units (as defined in the 1997 HCP).

Figure S-2. Estimated Change in Long-term Forest Cover Acres from Alternative A (No Action), by HCP Planning Unit



	OESF	Straits	North Puget	South Puget and Yakima	Columbia	South Coast
Alternative B	-12,000	-6000	-2000	-1000	-3000	-3000
Alternative C	5000	-3000	5000	1000	4000	4000
Alternative D	1000	-2000	4000	0	6000	5000
Alternative E	7000	-2000	6000	1000	4000	4000
Alternative F	30,000	-3000	42,000	21,000	12,000	12,000

■ Natural environment: Earth, climate, aquatic resources, vegetation, wildlife, and marbled murrelets

Forests within long-term forest cover are expected to become more structurally complex through time and experience less active management. Elements of the natural environment are not expected to be adversely impacted by these changes. Soil resources and areas subject to landslide hazards would continue to be protected by existing DNR regulations, policies, and procedures. The alternatives are not expected to exacerbate climate change impacts on any element of the environment, and carbon sequestration is expected to be greater than emissions under all alternatives.

Existing riparian protection strategies remain in place under all the alternatives, and aquatic functions are expected to be maintained or enhanced under all alternatives. Minor, localized impacts to microclimate are possible under Alternative B.

Some limitations on thinning (Alternatives C, D, and E) could delay some riparian or natural areas from meeting their restoration objectives within a shorter time frame. However, overall HCP, OESF, and natural areas management objectives are not impacted.

Many wildlife and plant species would benefit from an increase in structurally complex forest that will occur in long-term forest cover over the planning period. Some local changes in habitat conditions may have temporary negative impacts on some species, but overall abundance and distribution of species, including that of listed and sensitive species, would remain stable or increase on DNR-managed lands.

In areas where land would be "released" from its current conservation status (including 27,000 acres under Alternative B and between 2,000 and 3,000 acres in the Straits HCP planning unit under Alternatives C through F), the existing framework of regulations, policies, and procedures designed to minimize the environmental impacts from active management would remain in place.

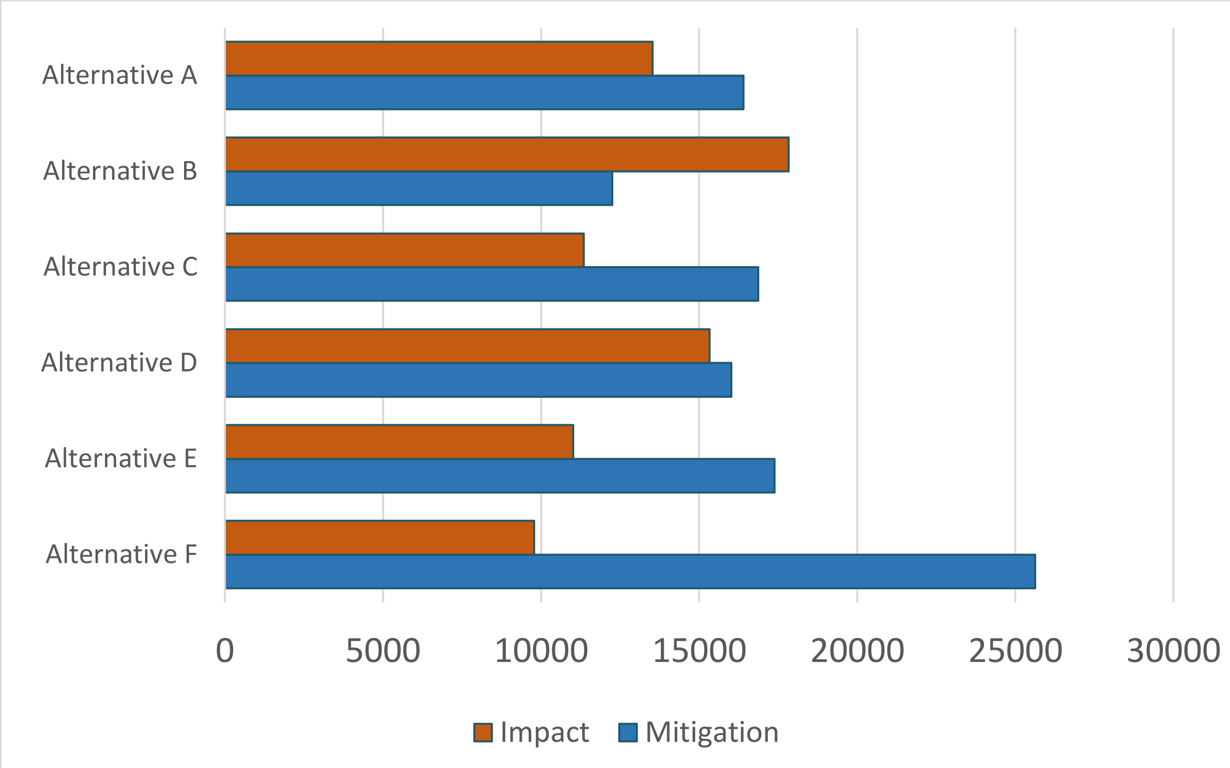
Impacts to marbled murrelet habitat and populations

The marbled murrelet population has declined at an average annual rate of 4.4 percent in Washington since monitoring began in 2001. Given this declining trend, it is uncertain whether the murrelet population will respond to increased habitat on federal or state lands in the future under any alternative. However, the distribution and trends in marbled murrelet populations is linked to the amount and configuration of nesting habitat. The alternatives recognize the importance of protecting existing occupied marbled murrelet habitat and recruiting additional habitat in specific areas. The alternatives vary by providing differing levels of habitat protection and recruitment, coupled with some short-term habitat loss. The intent is to improve current population trends through conservation and recruitment of additional nesting habitat on DNR-managed lands.

Two analytical approaches were used to estimate alternative-specific impacts to marbled murrelet habitat and populations. The acreage, quality (as influenced by stand condition and edge effects), and timing of habitat harvested and developed under each alternative provide a relatively direct measure of impacts. Potential impacts to the Washington murrelet population were evaluated with a mathematical population viability analysis model based on two different assumptions about the relationship of the murrelet population with forest habitat and other environmental factors: 1) insufficient forest habitat compounds negative effects of other factors, and 2) insufficient forest habitat is the principal negative influence on the murrelet population.

For all alternatives, habitat loss in the short term (the first decade of the planning period, due to harvest of habitat outside of long-term forest cover) is expected to be mitigated over time by the recruitment of more and higher-quality habitat and an increase in interior habitat in strategic locations within long-term forest cover. When the acres of this habitat are adjusted for quality and timing, the cumulative adverse impacts expected to marbled murrelet habitat are exceeded by the mitigation expected under every proposed alternative except Alternative B. Figure S-3 compares impacts to mitigated acres by the end of the 50-year planning period.

Figure S-3. Acres of Habitat Loss (Impact) and Gain (Mitigation) by the End of the Planning Period, by Alternative and Adjusted for Quality



Population viability analysis suggests that regardless of alternative, habitat conservation on DNR-managed land can do little at the statewide scale to influence either the risk of local declines or likelihood of population increases if other environmental factors are limiting, such as marine conditions. Assuming that nesting habitat is the primary limitation on murrelet population trends allows the analysis to evaluate the influence of habitat on DNR-managed land on local murrelet populations. The statewide population is projected to stabilize under all alternatives, while focusing just on DNR-managed lands suggested local population increases that vary in timing and magnitude were possible under all alternatives.

In summary, the population viability analyses suggest that Alternative B results in the highest risk of local declines and the lowest likelihood of local population increases during the modeled planning period. Alternative F is projected to result in the lowest risk of local declines and the highest likelihood of local population increases, with intermediate results projected under Alternative A and Alternatives C through E.

■ Human environment: Recreation, forest roads, public services and utilities, environmental justice, cultural resources, and socioeconomics

Some localized impacts to elements of the human environment are expected as a result of increasing the acres of marbled murrelet conservation and implementing proposed conservation measures. Cumulatively, these impacts are expected to be minor for all elements of the human environment except socioeconomics (refer to the following section), considering the scale of the analysis area and the availability of other DNR-managed lands for these land uses. Impacts are similar across all action alternatives.

Compared with the no action alternative, adding acres of marbled murrelet conservation would result in local reductions in the land available for new or expanded recreation facilities or non-timber leases/easements, shifting demand to lands elsewhere within the analysis area. Existing facilities, easements, leases, and land uses would remain largely unaffected, although the timing of some maintenance activities could be impacted.

Where conservation measures limit road development, compensatory increases in road miles may occur nearby, but overall road density in the analysis area is unlikely to increase as a result of the alternatives. Increased road abandonment in conservation areas would likely occur, which in turn could affect recreational use and access within these areas. Continued access to and use of cultural resources is unlikely to be significantly affected, however, and existing DNR policies and procedures for tribal consultation and cultural resource protection remain in place.

No environmental justice impacts under any alternative are anticipated from this conservation strategy, although local economic impacts in two counties could be adverse (as discussed in the next section).

Socioeconomic impacts

NEPA requires an examination of socioeconomic impacts of the proposed action. Socioeconomic impacts in this analysis concern the relationship of DNR-managed land to local economies, including county revenues, state trust revenues, employment, and local tax generation. These impacts were measured both qualitatively, by considering how activities on DNR-managed land contribute broadly to the local economy, and quantitatively, by attributing assumed values to the acres that would be available for harvest under each alternative.

The change in the value of "operable" acres was found to be relatively small at the scale of the analysis area. The overall change in operable acres ranges from a 4 percent increase under Alternative B to a decrease of between 1 and 4 percent for Alternatives C through F.

The federally granted trusts would experience minor gains in operable acres under Alternative B (increases between 1 and 6 percent) and minor reductions under Alternatives C through F (decreases between 1 and 6 percent). Exceptions would be the University Grant (original and transferred) Trust, which would see a larger reduction (between 11 and 18 percent) under Alternatives C through F, and the Scientific School Grant, which would see a 16 percent reduction under Alternative F. Counties benefiting from State Forest Trust lands would experience either no change or an increase in operable acres under Alternative B (increases up to 20 percent). Several counties would experience small changes in operable acres under Alternatives C through F (from decreases of 5 percent to increases up to 6 percent). Exceptions include Pacific County (13 to 23 percent decreases in operable acres) and Wahkiakum County (9 to 25 percent decreases) under Alternatives C through F. Under Alternative F, Whatcom and Pierce counties would experience reductions of operable acres of 22 percent and 11 percent, respectively.

Alternative B, by increasing the number of operable acres available for harvest as compared with Alternative A, is expected to result in stable or increased harvests levels on all trusts and in all counties in the analysis area, stable or increased revenue or all trust beneficiaries with lands within the analysis area, and stable or increased tax revenue and employment in counties within the analysis area.

Alternatives C, D, E, and F, by decreasing the number of operable acres available for harvest, are expected to result in stable or decreased harvest levels on most trusts and in all counties in the analysis area, stable or decreased revenue for most trust beneficiaries with lands within the analysis area, and stable or decreased tax revenue and employment in counties within the analysis area.

Pacific and Wahkiakum counties are most likely to be adversely impacted by Alternatives C, D, E, and F. These counties are more heavily dependent on timber harvest for local government revenue and have below-average economic diversity, compared with other counties in the analysis area. The economies of Pacific and Wahkiakum counties are therefore less able to tolerate the reduction in harvest volume anticipated under Alternatives C through F because of their low socioeconomic resiliency.

Some of the adverse economic effects due to reduced timber supply in the near term could be offset over time by the cumulative benefits of improved efficiencies and effectiveness in forest management, additional opportunities for thinning (which is more labor intensive), more regulatory certainty under the Endangered Species Act, and potential use of the State Forest Trust Land Replacement Program in Pacific and Wahkiakum counties.

■ Impacts on DNR operations

The establishment of discrete marbled murrelet conservation areas under the action alternatives will improve operational certainty (for example, in HCP implementation, harvest planning, road construction, leasing, and recreation planning) as compared with the no action alternative, which includes operational uncertainty about the exact location and extent of protected habitat. The conservation measures largely acknowledge the need for most DNR routine operations to continue to occur within long-term forest cover and limit restrictions or prohibitions to within specific marbled murrelet habitat areas. This means that active management of forest resources can largely continue, following clear parameters for seasonal timing restrictions, disturbance buffers, and need for consultation. For four types of operations within long-term forest cover (thinning, roads, blasting, and recreation), the conservation measures differ among alternatives, with some limiting DNR management activities more than others. Site-specific consultation with USFWS is expected under the proposed conservation measures for some forest management activities.

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Chapter 1

INTRODUCTION

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Chapter 1

Introduction

This chapter describes the proposed action and states the need, purpose, and objectives of this proposal. This chapter also outlines the regulatory and policy framework for the long-term marbled murrelet conservation strategy, describes the analysis area, and highlights the environmental impact statement and approval process.

1.1 Proposed Action: Need, Purpose, and Objectives

The action proposed by the Washington Department of Natural Resources (DNR) and the U.S. Fish and Wildlife Service (USFWS) is to amend DNR's 1997 *State Trust Lands Habitat Conservation Plan* (1997 HCP) by replacing the interim marbled murrelet (*Brachyramphus marmoratus*) conservation strategy described in that HCP with a long-term conservation strategy. An amendment to the HCP and associated incidental take permits[1] involves both state and federal action subject to the State Environmental Policy Act[2] (SEPA) and National Environmental Policy Act[3] (NEPA), respectively. This proposed action is considered a non-project action under SEPA.[4]

■ Need for the proposed action

DNR needs to obtain long-term certainty for timber harvest and other management activities on forested state trust lands, consistent with commitments in the HCP and DNR's fiduciary responsibility to the trust beneficiaries as defined by law.[5] USFWS needs to provide for conservation of the marbled murrelet by ensuring that the HCP meets permit issuance criteria under the Endangered Species Act (ESA) Section 10(a)(1)(B).

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[1] In this document, the term "incidental take permit" refers to all of the following: DNR's original incidental take permit [PRT 812521] issued by USFWS in 1997, amendments to that permit in 1998 and 1999, and an incidental take permit [PRT 1168] issued by WDFW in 2009 for six types of salmon stocks.

[2] Revised Code of Washington (RCW) 43.21C.

[3] 42 U.S.C. §4321 et seq. (1969).

[4] Non-project actions are "governmental actions involving decisions on policies, plans, or programs that contain standards controlling use or modification of the environment, or that will govern a series of connected actions." (SEPA Handbook, Chapter 4).

[5] Trust duties are discussed in more detail Section 1.2.

■ Purpose of the proposed action

The purpose of the proposed action is to develop a long-term conservation strategy for marbled murrelets on forested state trust lands in the six west-side planning units, subject to DNR's fiduciary responsibility to the trust beneficiaries as defined by law, and USFWS's responsibilities under the ESA, which achieves all of the following objectives:

- **Objective #1, Trust Mandate:** Generate revenue and other benefits for each trust by meeting DNR's trust management responsibilities. Those responsibilities include making state trust lands productive, preserving the corpus of the trust, exercising reasonable care and skill in managing the trust, acting prudently with respect to trust assets, acting with undivided loyalty to trust beneficiaries, and acting impartially with respect to current and future trust beneficiaries.
- **Objective #2, Marbled Murrelet Habitat:** Provide forest conditions in strategic locations on forested trust lands that minimize and mitigate incidental take of marbled murrelets resulting from DNR's forest management activities. In accomplishing this objective, we expect to make a significant contribution to maintaining and protecting marbled murrelet populations.
- **Objective #3, Active Management:** Promote active, innovative, and sustainable management on state trust lands.
- **Objective #4, Operational Flexibility:** Provide operational flexibility to respond to new information and site-specific conditions.
- **Objective #5, Implementation Certainty:** Adopt feasible, practical, and cost-effective actions that are likely to be successful and can be sustained throughout the life of the HCP.

1.2 Regulatory and Policy Framework

DNR-managed lands within the analysis area are subject to a variety of federal and state laws, as well as policies adopted by the Board of Natural Resources (Board). The long-term conservation strategy for the marbled murrelet must comply with these regulations and policies.

■ Federal Endangered Species Act

The purposes of the Endangered Species Act include protecting the ecosystems that threatened and endangered species depend on, providing a program that conserves populations of threatened and endangered species, and taking appropriate steps to achieve the purposes of the ESA. The long-term conservation strategy must meet multiple criteria under the ESA, including the following Section 10 issuance criteria:

- The taking will be incidental.
- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking.
- The applicant will ensure that adequate funding for the plan will be provided.
- The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild.
- Other measures, if any, that the Secretary may require as being necessary or appropriate for the purposes of the plan.[6]

Text Box 1.2.1

What is "take"?

"Take" is defined in the Endangered Species Act as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species. Harm may include significant habitat modification where it actually kills or injures a listed species through impairment of essential behavior (for example, nesting or reproduction).

■ 1997 Habitat Conservation Plan

The proposed action is an amendment to the 1997 HCP and associated incidental take permits.[7] The 1997 HCP is a long-term land management plan that is authorized under Section 10 of the ESA and prepared in partnership with the USFWS and National Marine Fisheries Service (NMFS). The 1997 HCP describes how DNR meets the ESA Section 10 criteria with a suite of habitat conservation strategies focused on northern spotted owls, marbled murrelets, salmon, and riparian obligate species, as well as other unlisted species (associated with uncommon habitats). These strategies range from passive (for example, protect unique habitats such as cliffs) to active (for example, thin forests to speed development of habitat). Through these HCP conservation strategies, DNR offsets the potential harm of forest management activities on individual members of a species by providing for conservation of the species as a whole.

[6] ESA Section 10(a)(2)(B); 16 U.S.C. § 1539(a)(2)(B).
[7] Refer to Implementation Agreement, 1997 HCP, Appendix B, page B.11.

A long-term conservation strategy for marbled murrelet would work in concert with the other existing HCP conservation strategies. The objectives and approaches described in the riparian conservation strategy, northern spotted owl conservation strategy, and the protection of uncommon habitats do not change through this SEPA/NEPA planning process. Under some of the alternatives analyzed in this Draft Environmental Impact Statement, some existing, permitted activities may be modified at the local scale to enhance their conservation benefit for marbled murrelets. The effect of the long-term strategy alternatives on existing conservation strategies will be discussed in more detail in the following chapters.

An HCP is a required component of an application for an incidental take permit, which is required when activities occurring on non-federal lands, such as timber harvests, have the potential to result in incidental take of a threatened or endangered species. Incidental take means harm or harassment to individuals of a listed species when such take is incidental to, and not the purpose of, carrying out otherwise lawful activities such as timber harvests (DNR 1997). The contents of an HCP are defined in Section 10 of the ESA and its implementing regulations. They include:

Text Box 1.2.2

Will the long-term strategy amend the existing HCP conservation strategies?

The long-term strategy focuses on marbled murrelet conservation and is intended to work with the existing conservation strategies of the HCP. Under some alternatives proposed in this DEIS, some existing, permitted activities may be modified at the local scale to enhance their conservation benefit for marbled murrelets.

- An assessment of the impacts likely to result from the proposed taking of one or more federally listed species.
- Measures the permit applicant will undertake to minimize, mitigate, and monitor for such impacts; the funding that will be made available to implement such measures; and the procedures to deal with unforeseen or extraordinary circumstances.
- Alternative actions to the taking that the applicant analyzed and the reasons why the applicant did not adopt such alternatives.
- Additional measures that USFWS may require as necessary or appropriate.

■ State Trust Lands

By meeting the terms of the 1997 HCP and incidental take permits, DNR fulfills its obligations under the ESA. The 1997 HCP and incidental take permits provide DNR the stability, certainty, and flexibility it needs to meet its responsibility as a trust lands manager, which is to provide a perpetual source of revenue to its trust beneficiaries while simultaneously developing a complex, healthy, resilient forest ecosystem capable of supporting native species. As a trust lands manager, DNR must follow the common law duties of a trustee. Two of these duties were addressed in the 1984 landmark decision *County of Skamania v. State of Washington*: 1) a trustee must act with undivided loyalty to the trust beneficiaries to the exclusion of all other interests, and 2) a trustee has a duty to manage trust assets prudently (DNR 2006, p. 15). Refer to the *Policy for Sustainable Forests* for a more detailed discussion of DNR's trust management duties (DNR 2006, p. 9–16).

For a more detailed explanation of the ESA's Section 10 process as it applies to this conservation strategy, refer to Section 1.4.

This DEIS refers to "state trust lands" or "trust lands" to describe the following trusts defined under state law and managed by DNR to provide revenue to specific trust beneficiaries. Chapter 3 provides information on the acres of each trust within the analysis area. The term "state trust lands" used in this DEIS refers to:

- **State Lands** (RCW 79.02.010(14)): Shortly before Washington became a state in 1889, Congress passed the Omnibus Enabling Act of 1889 (Volume 25, U.S. Statutes at Large, Chapter 180, p. 676) to grant the territory more than 3 million acres of land as a source of financial support for named beneficiaries, primarily for public schools and colleges. Unlike states that sold many of their federally granted lands early in the 1900s, Washington retained ownership of most of these lands and continues to manage them to provide revenue and other benefits to the people of Washington (DNR 2006). These lands are called State Lands.
- **State Forest Lands** (RCW 79.02.010(13)): DNR manages two categories of State Forest Lands. *State Forest Transfer Lands* were acquired by 21 counties in the 1920s and 1930s through tax foreclosures. Unable to manage these mostly harvested and abandoned lands, counties deeded them to the state to manage as state trust lands. In exchange for the deed transfer, the county and taxing districts in which the land is located are given most of the revenue from timber sales and other revenue-producing activities. *State Forest Purchase Lands* were either purchased by the state or acquired as a gift. State forestlands are to be used primarily for forestry, forever reserved from sale, and managed similar to federally granted trust lands.

Two other trusts are located within the analysis area, covering significantly fewer acres:

- **Community College Forest Reserve** (RCW 79.02.420): In addition to the State Lands and State Forest Lands, DNR also manages more than 3,200 acres of forestlands for community colleges. The Community College Forest Reserve was established by the Legislature in 1996. Funds for DNR to purchase the properties were first appropriated that year.

  These lands, located near urban areas, form a buffer between other working forests and suburban uses. The properties are managed for sustained timber production, but special consideration is given to aesthetics, watershed protection, and wildlife habitat. Revenues go to a special fund for building and capital improvements on community college campuses.
- **King County Water Pollution Control Division State Trust Lands**: DNR manages more than 4,300 acres of state trust lands for the benefit of King County and its Wastewater Treatment Division. These lands were transferred to DNR for management through an agreement with the county in June 1995 and are managed for long-term forestry, the same as other state trust lands. Some of the King County's biosolids will be applied to these lands where soils and locations are appropriate.

■ Policy for Sustainable Forests

The *Policy for Sustainable Forests* (DNR 2006) is DNR's guiding set of policies for the management and stewardship of forested state trust lands. The Policy describes DNR's obligations for managing forestlands on behalf of the state trusts (refer to "State Trust Lands" in the preceding section), and establishes specific policies around economic performance, forest ecosystem health and productivity, and social and cultural benefits. The policies in this document work to support implementation of the 1997 HCP. Therefore, this DEIS uses the *Policy for Sustainable Forests* to establish criteria for the analysis of potential environmental consequences of the alternatives (Chapter 4). The multiple benefits from state trust land management are discussed in the *Policy for Sustainable Forests*; policies are grouped into major categories that address key aspects of sustainable forest management including economic performance, forest ecosystem health and productivity, and social and cultural benefits (DNR 2006, p. 25–50).

Sustainable harvest calculation

The sustainable harvest calculation is approved by the Board of Natural Resources and establishes a sustainable harvest level of timber to be scheduled for sale from DNR-managed state trust lands during a planning decade.[8] The marbled murrelet long-term conservation strategy will have implications for the sustainable harvest calculation. An update to the calculation, which is currently underway, will incorporate a range of conservation lands proposed under the marbled murrelet long-term conservation strategy alternatives in order to properly analyze potential harvest levels.[9] Ultimately, both the marbled murrelet long-term conservation strategy and the sustainable harvest calculation will be considered together by the Board of Natural Resources to determine appropriate harvest levels.

Old-growth stands in western Washington

The *Policy for Sustainable Forests* includes provisions to identify and protect old-growth forests. These forests are defined as stands of pre-European settlement origin (prior to the year 1850) that have not been actively managed. These stands have a high level of structural complexity and provide conditions for marbled murrelet nesting. DNR maintains an inventory of old-growth forest stands of at least 5 acres in size. Protection of these stands is a key component of the 1997 HCP, as they provide conservation benefit to the northern spotted owl and riparian habitat, as well as the marbled murrelet. In the Olympic Experimental State Forest (OESF), some management of old-growth stands is allowed, consistent with the HCP and research objectives of this planning unit.

[8] RCW 79.10.300(5).
[9] Information on the sustainable harvest calculation update can be found at www.dnr.wa.gov/shc.

State Forest Practices Act

In 1974, the Legislature passed the Forest Practices Act, which regulates activities such as growing and harvesting timber on all non-federal forestlands in the state, including forested state trust lands.[10] The Forest Practices Board adopts forest practices rules that implement the Act.[11]

In 1999, the legislature directed the Forest Practices Board to amend the rules to be consistent with the April 1999 *Forests and Fish Report*.[12] The objectives of that report are to protect public resources, focusing on water quality, salmon habitat, federally-listed species, and other aquatic and riparian resources. The legislature also directed that the Governor to seek assurances from federal agencies so that compliance with the forest practices rules would satisfy federal requirements under the endangered species act.[13] In 2001, the Forest Practices Board amended the rules and in 2006, the USFWS and NMFS approved the programmatic *Forest Practices Habitat Conservation Plan* and associated incidental take permits to conserve fish and seven amphibian species. The Forest Practices HCP provides ESA coverage for forest landowners through the state's Forest Practices program.

Field staff in DNR's six regions administer and enforce the Forest Practice rules (and thus the Forest Practices HCP). DNR's Forest Practices Division provides staff support to the Forest Practices Board and programmatic oversight for the regions and is entirely independent of DNR's divisions that manage forested state trust lands. Specific forest practice rules apply to forest practices covered by an HCP such as the 1997 State Trust Lands HCP.[14] Forest practices activities on DNR-managed lands not covered by the 1997 HCP (some limited acreage in western Washington but mostly eastern Washington) obtain ESA coverage through the Forest Practices HCP.

National Environmental Policy Act

The purpose of NEPA is to promote analysis and disclosure of the environmental issues surrounding a proposed federal action. The scope of NEPA goes beyond that of the ESA by considering the impacts of a federal action not only on fish and wildlife resources, but also on other aspects of the environment such as water quality, cultural resources, recreation, and other pertinent areas depending on the scope of the action. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences and take actions that protect, restore, and enhance the environment.

[10] RCW 76.09.
[11] RCW 76.09.030, 040.
[12] RCW 77.85.180.
[13] RCW 77.85.190.
[14] WAC 222-16-080(6)(i), Exempting forest practices consistent with HCP from Class IV-Special classification; WAC 222-12-041(3)(a), Use of HCPs for aquatic resources.

Other related laws and policies

DNR complies with all other applicable state and federal laws. Some examples include the state Shoreline Management Act,[15] which is intended to protect valuable shoreline resources, and the state and federal Clean Water Acts,[16] which establish the basic structure for regulating discharges of pollutants into the waters of the United States. The state and federal Clean Air Act,[17] SEPA,[18] and certain local laws also affect the management of state trust lands. Chapter 3, Affected Environment, summarizes the applicable laws and policies for each element of the environment evaluated for impacts.

Natural areas

DNR manages a statewide system of conservation lands called natural areas that contribute to biodiversity conservation in Washington and are included in the 1997 HCP as “permit lands.” Natural Area Preserves (NAPs) protect rare or vanishing flora, fauna, and geological, natural historical, or similar features of scientific or educational value.[19] Natural Resources Conservation Areas (NRCAs) include areas with a high priority for conservation, natural systems, wildlife, significant geologic features, archaeological resources, or scenic attributes and often provide public access.[20] DNR actively manages natural areas to ensure control of invasive species and to restore native species. NAPs and NRCAs are included in the marbled murrelet long-term conservation strategy where they provide habitat and security to marbled murrelet habitat.

[15] RCW 90.58.
[16] 33 U.S.C. §1251 et seq. (1972); RCW 90.48.
[17] 42 U.S.C. §7401 et seq. (1970); RCW 70.94.
[18] RCW 43.21C.
[19] RCW 79.70.
[20] RCW 79.71.

1.3 The Analysis Area

The analysis area for this DEIS is all DNR-managed lands (approximately 1.377 million acres) within 55 miles of all marine waters in western Washington (refer to Figure 1.3.1). This 55-mile line is the same as was used in the *Northwest Forest Plan* (USDA 1994) and is used by USFWS as an estimate of the inland range of the marbled murrelet in Washington.

Figure 1.3.1. Analysis Area for the DEIS

The total land within the 55-mile range totals over 16 million acres. DNR manages approximately 9 percent of this land. DNR organizes its habitat conservation on ecological units called "HCP planning units," which include Olympic Experimental State Forest, Straits, South Coast, Columbia, North Puget, and South Puget. State trust lands managed under the 1997 HCP within these planning units are the areas where the marbled murrelet long-term conservation strategy will be implemented.

Other lands within the inland nesting range of the marbled murrelet are owned and managed by private industries, municipalities, organizations, and individuals, as well as federal agencies. Table 1.3.1 includes a breakdown of ownership.

Table 1.3.1. Land Ownership Within the Washington Inland Range of the Marbled Murrelet

Land within 55 miles of saltwater	Acres	
Total land regardless of ownership	16,056,074	
	Acres	Percent
US Forest Service, USFWS, and National Park Service land	4,165,681	26%
DNR-managed land	1,377,933	9%
Private and other	10,512,460	65%

1.4 Environmental Impact Statement (EIS) and Approval Process

Figure 1.4.1 shows the steps of this project, from scoping through final approval. Each of these steps is described in the following section.

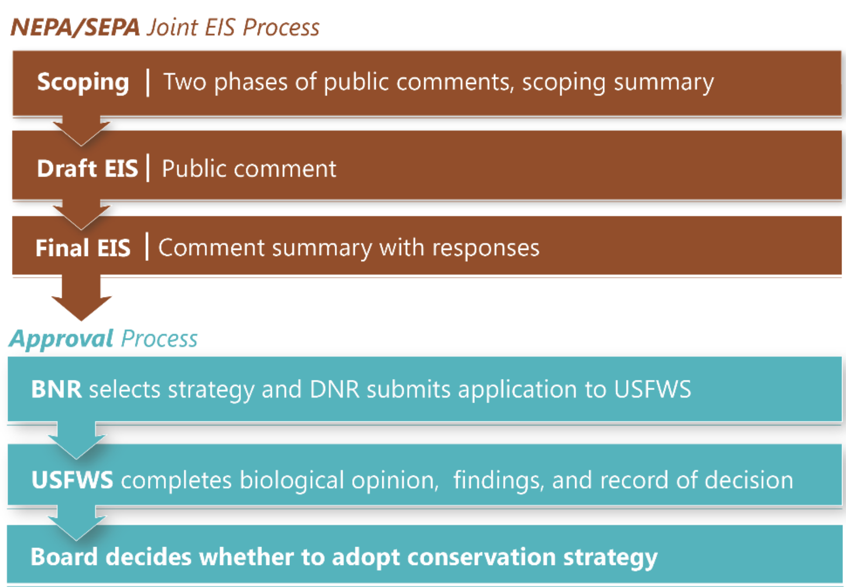
■ Scoping

Scoping involves defining the range of the issues to be addressed in an EIS. Scoping helps the lead agency recognize areas of concern and eliminate less significant impacts from detailed study, which helps focus the EIS. Comments from concerned citizens and organizations help agencies identify reasonable alternatives to be analyzed in an EIS, and the opportunity to comment during the scoping process also helps promote agency and public communication.

2006 Determination of Significance and Public Scoping Notice

On September 15, 2006, DNR issued a *Determination of Significance and Public Scoping Notice* for the long-term marbled murrelet conservation strategy, indicating that an EIS would be prepared. On that same date, USFWS, as joint lead agency, issued a federal Notice of Intent to conduct public scoping and prepare a joint EIS (71 Federal Register 54515). The proposal's geographic area at that time included OESF, Straits, South Coast, and Columbia HCP planning units only.

Figure 1.4.1. EIS and Approval Process



After the public scoping notices were issued, DNR and USFWS held four public meetings at the following dates and locations:

- September 25, 2006: Olympic Natural Resources Center, Forks
- September 28, 2006: Natural Resources Building, Olympia
- October 4, 2006: Willapa Harbor Community Center, South Bend
- October 5, 2006: Lacey Community Center, Lacey

Ten scoping comments were received during the scoping comment period (September 15 through October 30, 2006). DNR decided not to proceed immediately with development of the EIS for the long-term strategy because of the economic downturn and resulting budget cuts.

2012 project resumption

In January 2012, USFWS and DNR resumed development of the EIS for the long-term strategy as Joint Lead Agencies pursuant to their respective authorities under NEPA and SEPA and reinitiated and expanded public scoping due to the passage of time since the original scoping notice was issued. Subsequently, DNR and USFWS jointly prepared a statement of need, purpose, and objectives consistent with their respective authorities in order to facilitate the identification of a reasonable range of alternatives.

2012 and 2013 scoping

Scoping was done in two 30-day phases for the preparation of the DEIS. Phase 1 was initiated on April 20, 2012, when DNR issued a Public Scoping Notice and USFWS issued a federal Notice of Intent to conduct scoping (77 Federal Register 232743). In Phase 1, DNR and USFWS requested public comment related to the following: a proposed statement of need, purpose, and objectives, range of alternatives, impacts that should be considered, and environmental information relevant for the analysis for the long-term marbled murrelet conservation strategy. (These comments would be in addition to those received during the 2006 scoping process, which were retained by both agencies.) In addition, the Joint Lead Agencies geographically expanded the proposal to include the North and South Puget HCP planning units. Meetings were held in western Washington on these dates:

- April 30, 2012: Natural Resources Building, Olympia
- May 3, 2012: Northwest Region Office, Sedro-Woolley
- May 8, 2012: Pacific Cascade Office, Cathlamet
- May 9, 2012: Olympic Region Office, Forks

In all, about 2,040 individual comments were received during the Phase 1 scoping period (April 20 through May 21, 2012). Comments were summarized by subject.

At the August 2012 Board meeting, the Board (with USFWS support) approved the need, purpose, and objectives statement for inclusion in the DEIS.

Subsequently, DNR and USFWS decided to hold a second phase of scoping. On May 13, 2013, DNR issued a *Notice of Public Meetings and Request for Comments on the Scope of an Environmental Impact Statement*, initiating Phase 2 of scoping. Though not required under SEPA or NEPA, Phase 2 scoping increased the opportunities available to the public to learn about and provide input into the conservation strategy process. In this second phase of scoping, DNR and USFWS sought public comment on a set of conceptual alternatives for the conservation strategy. Public meetings were held on these dates:

- June 5, 2013: Natural Resources Building, Olympia
- June 10, 2013: Northwest Region Office, Sedro Woolley
- June 12, 2013: Olympic Region Office, Forks
- June 19, 2013: Pacific County Courthouse Annex, South Bend

During the Phase 2 scoping period (May 13 through July 1, 2013), 1,976 individual comments were received regarding DNR's and USFWS's conceptual alternatives. These comments were summarized by subject in July and August 2013. By reviewing all of the comments from the 2006 scoping and both phases of the 2012–2013 scoping, DNR and USFWS narrowed the scope of issues for consideration in this DEIS. Refer to Appendix A for the scoping summary report provided to the Board.

2015 public comment

In addition to the formal scoping process, DNR presented draft alternatives to the Board of Natural Resources in October 15 and December 3, 2015. Public comment received during those meetings was also considered and is summarized in the Scoping Report in Appendix A.

■ Development of the DEIS and Final EIS (FEIS)

Following scoping, DNR and USFWS jointly developed a set of management alternatives through a collaborative working process. The alternatives represent different management options to USFWS and DNR decision-makers and reflect the ideas and concerns raised by the public and stakeholders during the entire scoping process.

USFWS and DNR then prepared this DEIS. This document analyzes a reasonable range of alternatives to identify potential environmental impacts and mitigation measures under both NEPA and SEPA.

The comment period for the DEIS begins when the DEIS is formally issued. The comment period gives the public a chance to comment on the DEIS. After the comment period, DNR and USFWS will review and consider all comments received and prepare an FEIS.

Who is the DNR decision maker?

DNR's decision maker for this action is the Board of Natural Resources (Board). Board approval is required for this project because the proposal would amend an existing Board-approved policy, the 1997 HCP. As the decision maker, the Board will be responsible for selecting a final alternative plus any proposed mitigation. The Board may adopt an alternative in its entirety or it may combine elements of different alternatives. Although the final selected alternative may not be identical to any one particular alternative in this DEIS, it will be within the range of alternatives analyzed.

Text Box 1.4.1

What is the Board of Natural Resources?

The Board of Natural Resources (Board) was established when DNR was created in 1957. The Board sets policies ensuring that the acquisition, management, and disposition of the lands and resources in DNR's care are based on sound principles and consistent with applicable laws. The Board approves timber sales and the sale, exchange, or purchase of state trust lands and also establishes the sustainable harvest level for forested state trust lands. Any change to DNR policies requires Board approval.

Membership in the Board is set by state statute and includes: the Commissioner of Public Lands, the Governor of Washington or designee, the Washington Superintendent of Public Instruction, a county commissioner from a county with state trust lands, the Director of the School of Environmental and Forest Sciences at the University of Washington, and the Dean of the College of Agriculture, Human, and Natural Resource Sciences at Washington State University.

■ USFWS approval process

Once the Board selects the final alternative for the long-term marbled murrelet conservation strategy, DNR will prepare and submit an application to the USFWS to amend the 1997 HCP.

Upon submission of the Board-approved alternative, along with a complete application (previously described in Section 1.2), USFWS is responsible for determining sufficiency under the ESA. This includes the completion of both a Section 7 consultation and a Section 10 finding. The Section 7 consultation will conclude with a biological opinion with a determination of whether the proposed action will "not appreciably reduce the likelihood of the survival and recovery of the species in the wild." The Section 10 findings will evaluate if all the issuance criteria (listed Section 1.2) are adequately satisfied.

At the time of the USFWS decision, the agency must prepare a NEPA record of decision (ROD) explaining how they arrived at the decision. The ROD must include: what the decision was; alternatives considered and the environmentally preferred alternative(s); a statement of whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted; and a monitoring and enforcement program for adopted mitigation measures (40 CFR 1505.2).

Is this the end of the process?

No. Once USFWS has made its final determination on whether to approve DNR's application, the Board will decide whether DNR will adopt the conservation strategy and accept the permit terms and conditions.

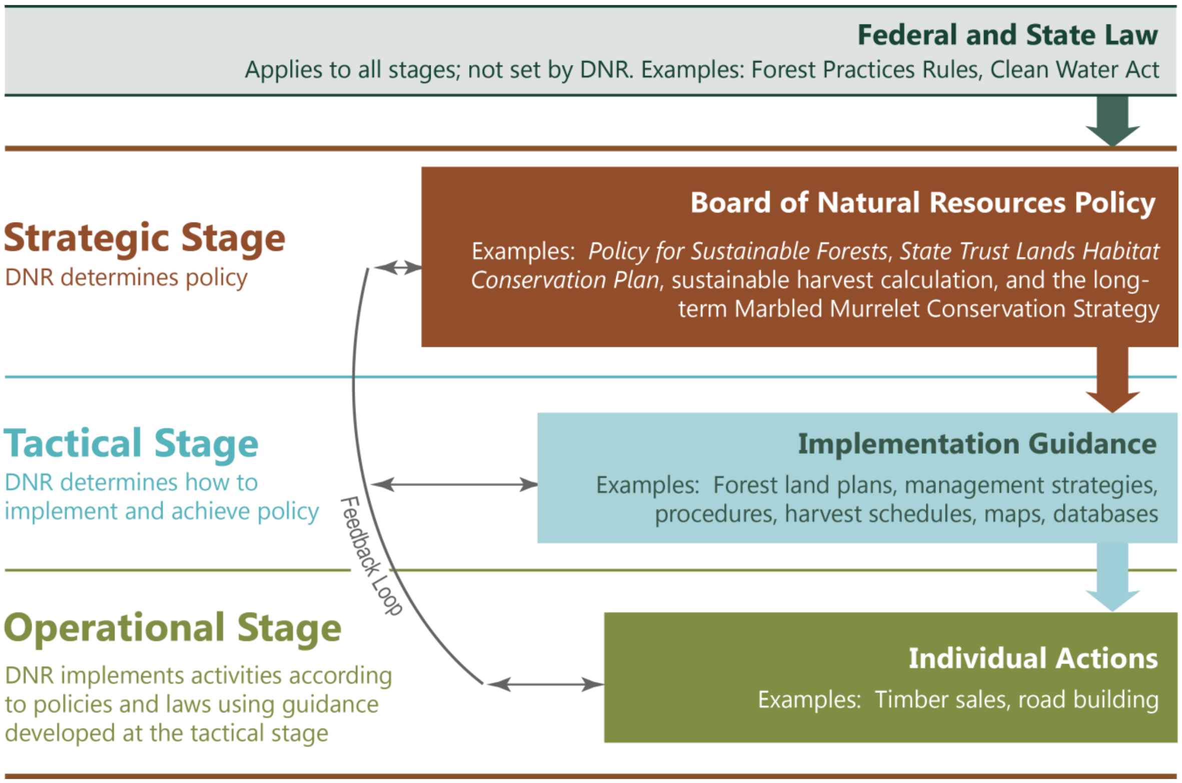
Will the long-term conservation strategy affect other DNR planning processes?

Yes. To understand why and how, it is important to understand DNR's planning process. This process has three stages: strategic, tactical, and operational (refer to Figure 1.4.2).

The first planning phase is called **strategic** because it involves developing policies that define DNR's basic operating philosophy, establish standards, and provide direction upon which subsequent decisions can be based. Examples of policies include HCPs and the *Policy for Sustainable Forests*. Amendment of the 1997 HCP and incidental take permits for the long-term marbled murrelet conservation strategy both fall within the strategic level of planning. All of these policies require approval from the Board of Natural Resources.

Another example of a strategic level of planning is the sustainable harvest calculation. As described above, the sustainable harvest calculation establishes the volume of timber to be scheduled for sale from state trust lands during a planning decade. The sustainable harvest calculation policy has some flexibility designed to optimize the economic value of forest stands and timber production over time. Within the planning decade, the harvest level in any given year can vary up to 25 percent (plus or minus) from this amount, but the decadal mean must be sustained over the decade. This ensures that timber harvesting continues into the future in a way that is fair to all generations of trust beneficiaries. The sustainable harvest level is recalculated each decade. However, DNR may recalculate the level more often to accommodate new legal, economic, and environmental considerations. One such consideration would be development of the long-term marbled murrelet conservation strategy, which may affect both harvest volumes and the placement of harvests on the landscape. Once the long-term strategy has been adopted, DNR will adjust the sustainable harvest level as necessary to meet the strategy's requirements (DNR 2006).

Figure 1.4.2. DNR's Planning Process



The second stage in DNR's planning process is called **tactical** because it involves determining how to implement and achieve DNR policies. At this stage, DNR may develop specific management strategies, maps, databases, models, or other items designed to achieve specific policy objectives. DNR may also develop comprehensive documents called forest land plans, through which DNR determines the best way to implement the full suite of DNR policies in a given planning unit. To date, DNR has completed forest land plans for the South Puget planning unit and the OESF planning unit.

Because they are based on DNR policies, forest land plans and other items developed at the tactical stage must be amended if those policies change. The long-term marbled murrelet conservation strategy may affect procedures, management strategies, and other key elements of DNR's forest land plans. Such elements will be adjusted to the new long-term strategy as appropriate.

Site-specific activities such as individual timber sales are designed at the **operational** stage of planning using the guidance developed at the tactical stage. Management activities must comply with all applicable local, state, and federal laws as well as policies developed at the strategic stage.

Review under SEPA occurs at each stage of planning. Policies are evaluated at the strategic phase, forest land plans are reviewed at the tactical stage, and most site-specific projects or actions, such as individual timber sales, are evaluated at the operational stage as they are proposed.[21]

Text Box 1.4.2

After a long-term strategy is adopted, will individual projects in the analysis area still be reviewed under SEPA, NEPA, and other laws?

Yes, unless they are exempt under state or federal law. As a non-project action under SEPA, the long-term conservation strategy is not site-specific. Supplemental review of site-specific projects such as timber sales, recreation site development, major leases, and easements will occur under SEPA (and if a federal project, under NEPA) and any other applicable local, state, or federal law.

What is the time frame for the long-term strategy?

The long-term conservation strategy follows the timeline of the 1997 HCP, which runs to the year 2067. All analysis conducted in this DEIS considers 2015 as the starting point and 2067 as the ending point. Data is often presented in terms of the decade of the strategy (first decade through final decade) for comparison purposes.

■ What is in the other chapters of this DEIS?

Chapter 2, The Alternatives, describes the six alternatives in detail, with information about how the alternatives were developed, what conservation lands are being proposed under each alternative, conservation measures that apply to different forest management activities and land uses in the conservation areas, and data comparing the alternatives with one another.

Chapter 3, Affected Environment, describes elements of the natural and built environment likely to be affected by the alternatives are summarized and provides current conditions against which the DEIS will evaluate potential impacts from the alternatives.

Chapter 4, Environmental Consequences, analyzes the potential impacts from the different alternatives on the elements of the environment described in Chapter 3.

Chapter 5, Cumulative Effects, provides a synthesis of the potential cumulative effects of the alternatives and other activities, actions, and trends taking place within the analysis area.

Chapter 6, Literature Cited, identifies the materials and sources referred to throughout this DEIS.

Chapter 7, Key Definitions, presents terms used in this DEIS.

[21] Some actions are exempt from SEPA review by statute or rule. Refer to RCW 43.21C.037, Exempting Class I, II, or III forest practices defined in WAC 222-16-050—includes pre-commercial thinning and tree planting; WAC 332-41-833, Exempting certain small timber sales; WAC 197-11-800, 830, SEPA categorical exemptions for minor activities.

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Chapter 2

THE ALTERNATIVES

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Chapter 2

The Alternatives

In this chapter, DNR and USFWS (Joint Agencies) describe six alternatives being considered for the long-term strategy, including a no action alternative. These alternatives represent a range of conservation strategies for the marbled murrelet on DNR-managed lands. Conservation measures common to the alternatives are described, and the features of the alternatives are compared to one another.

2.1 Developing and Screening the Alternatives

The Joint Agencies worked together to develop six alternatives within the range of the marbled murrelet to analyze in this DEIS, including the no action alternative. These alternatives cover a range of acres and configurations of DNR forestland that is managed for marbled murrelet conservation. The alternatives differ in the amount of land that is designated for marbled murrelet conservation, where conservation is located, and how conservation areas will be managed. Development of these alternatives was informed by the scoping process described in Chapter 1; Appendix A provides a summary of this process and the comments received. The alternatives were screened by the Joint Agencies for their ability to potentially meet the project's adopted need, purpose, and objectives and basic criteria under the Endangered Species Act. A discussion of how the alternatives address project objectives is included at the end of this chapter.

Text Box 2.1.1

What are the main differences among the alternatives?

The alternatives differ in the amount of forestland designated for marbled murrelet conservation, where conservation is located, and how conservation areas will be managed.

How were the alternatives developed?

The Joint Agencies used an analytical framework to guide the process of developing and screening alternatives (refer to Appendix B: Analytical Framework focus paper). The framework used scientific methods to identify habitat, analyze habitat quality, calculate impacts and mitigation, and estimate marbled murrelet population impacts over the planning period. This work was used to design and compare the action alternatives.

Conservation approaches that were not developed into alternatives

Potential conservation approaches that did not meet the need, purpose, and objectives (refer to Chapter 1) were not considered feasible and were not developed into alternatives. These included:

1) ***Removing HCP coverage*** for the marbled murrelet and managing instead under the forest practices rules (WAC 222) and existing DNR policies. This approach could not achieve the need, purpose, and objectives and was rejected for several reasons:
    - Removing HCP coverage would not provide DNR with certainty that it could meet its trust obligations through continued, sustainable timber management.
    - Managing under only the forest practices rules would mean potential costly delays to the timber sale process due to required surveys of each stand for murrelet presence (a one- to two-year process with up to 18 site visits (Evans Mack and others 2003)) and consultation with USFWS each time potential habitat impacts are identified.
    - Performing the sustainable harvest calculation that DNR relies on to plan its harvest schedules would be very difficult with this level of uncertainty.
    - Removing HCP coverage would also be unlikely to provide a significant contribution to protecting the murrelet population, as DNR would not be setting aside lands to protect and grow murrelet habitat over the long term, but would instead be managing habitat on a piecemeal basis. This could foreclose future options for nesting habitat development in areas strategically important to the population.

2) ***Ceasing timber harvest activities*** on DNR-managed state trust lands. This approach was not considered feasible as it would violate DNR's trust obligations set forth in state law and the need, purpose, and objectives (Objective #1; refer to Chapter 1 for a description of state trust lands).

Supplementary analyses

Although these approaches were not considered feasible, the Joint Agencies did conduct some additional analyses to explore a variety of the following scenarios that were not included as action alternatives:

- Analyzing no harvest of DNR-managed land through the planning period or immediate removal of all DNR-managed habitat. These scenarios were requested to be explored by the Board of Natural Resources. The purpose of analyzing these two scenarios was to understand the outermost boundaries of the model's outputs for the marbled murrelet population (refer to Appendix C: Population Viability Analyses (Peery and Jones 2016))

- Including "stringer" habitat (defined in Section 2.4, Habitat Configuration) in order to understand the effect this habitat might have on the population.

- Metering of the harvest of marbled murrelet habitat. The purpose of this scenario was to model how delaying initial harvest impacts may affect the population over time.[1]
- Including a larger buffer (150 meters) on occupied sites, requested by the Board to test the sensitivity of Alternative F and how the balance of impacts and mitigation changes.[2]
- Excluding northern spotted owl habitat from long-term forest cover, requested by the Board, to minimize overlap of the marbled murrelet strategy and the owl strategy in the 1997 HCP.

All scenarios except the last two in the preceding bulleted list were analyzed using a population viability analysis (refer to Appendix C). Similar population modeling done for the action alternatives is more fully described in Section 4.6, Marbled Murrelet.

These supplementary analyses, although not incorporated into an action alternative, informed deliberations about the alternatives.

■ Why do we need a long-term strategy now?

Approval of a long-term conservation strategy for the marbled murrelet is timely. Active forest management is ongoing on DNR-managed lands under the interim strategy, and approving a long-term strategy will avoid foreclosing future options for protecting strategically located marbled murrelet habitat. Approving a long-term strategy will also help ensure sustainable management of state trust lands. Further delay in the development of a long-term strategy would mean the data used to identify potential nesting habitat and model habitat growth under the proposed alternatives would become out of date, and delay could also have consequences for DNR's compliance with federal permits under the 1997 HCP.

■ How is marbled murrelet habitat identified?

Across the analysis area, the Joint Agencies identified DNR-managed forestlands that have the characteristics of murrelet nesting habitat and those areas that should be considered for a long-term conservation strategy. Habitat characteristics important to the marbled murrelet include large nesting platforms on mature trees, adequate canopy cover, and sufficient interior forest to provide security to nesting murrelets from predation and other forest edge effects. To identify this habitat, the Joint Agencies built upon previous survey work, habitat relationship studies, and a habitat classification model known as "P-stage" that was first developed by a team of scientists convened by DNR in 2004.

[1] Analysis of including stringers and metering was presented to the Board of Natural Resources on June 7, 2016.
[2] Analysis of a larger buffer and excluding owl habitat were discussed with the Board of Natural Resources on August 11, 2016.

Role of the Science Team recommendations

In 2004, DNR convened a team of professionals to compile expert opinion, data, and research on marbled murrelet habitat conservation. These specialists, known as the Science Team, completed a set of recommendations in 2008 for DNR to consider when developing a long-term conservation strategy for the marbled murrelet. Entitled *Recommendations and Supporting Analysis of Conservation Opportunities for the Marbled Murrelet Long-Term Conservation Strategy* (Science Team Report), the report provides a landscape-level examination of proposed conservation areas on DNR-managed lands on the Olympic Peninsula and Southwest Washington (not North or South Puget). The analysis was built upon objectives designed to recover marbled murrelets on DNR-managed lands and did not consider DNR's fiduciary responsibility to its trust beneficiaries, with the exception of special considerations for Wahkiakum and Pacific counties. The report's recommendations were not adopted as a long-term conservation strategy or policy by the Board of Natural Resources.

However, the report made considerable contributions toward the development of alternatives for this DEIS. The Science Team examined the relationship of the structure and composition of forest stands with their potential contribution to carrying capacity for marbled murrelets. This analysis provides a critical foundation for the habitat model referred to as "P-stage," which DNR and USFWS use to estimate the area of current and future murrelet habitat in all of the alternatives described in this chapter. The Science Team also evaluated occupied sites resulting from surveys on DNR lands. They addressed concerns about the accuracy of occupied site boundaries by re-delineating the boundaries of specific occupied sites as necessary (adding approximately 16,000 acres). The Science Team also made conservation recommendations for occupied sites surveyed under Pacific Seabird Group survey protocols released before 2003. (Refer to Raphael and others 2008 in Appendix E for detailed description.) DNR and USFWS used these delineations and recommendations for occupied sites in Alternatives B through F, with an exception regarding buffer width for two alternatives. Finally, the conservation areas recommended by the Science Team on the Olympic Peninsula and in southwest Washington are incorporated into Alternative F. For this alternative, conservation areas in North and South Puget planning units, which were designed using Science Team principles, are also included.

Occupied marbled murrelet sites

Previous survey work and habitat relationship studies done by DNR under the interim strategy resulted in the identification of 44,722 acres of occupied sites on DNR-managed forestlands in the analysis area. Occupied sites are habitat patches of varying size where murrelets are assumed to nest based on field observations. Occupied sites identified through HCP survey work are maintained as habitat and are not currently subject to harvest. Work by the Science Team identified an additional 16,000 acres of occupied sites, and these sites are used in all of the action alternatives. (Refer to Appendix D for a detailed description of how occupied sites were identified.)

Applying the P-stage model

In addition to occupied sites, the Joint Agencies have identified where other potential nesting habitat may currently exist on DNR-managed lands, or where it is likely to develop during the life of the HCP. To find these areas, DNR applied the Science Team's landscape-scale habitat classification model called "P-stage." The P-stage model, developed for the 2008 Science Team report (Raphael and others 2008), uses forest inventory data (including forest type, stand origin, and stand age) to estimate the location and quality of murrelet habitat. (Refer to Appendix E for a detailed description of the P-stage model, including a comparison of this model with other available habitat models.) Habitat is assigned a P-stage value based on its quality, ranging from relatively low-quality habitat on up to higher-quality habitat. P-stage values increase over time as the forest grows and develops more structure suitable for nesting and secure canopy cover (refer to Figure 2.2.1).

P-stage was used to inform the Joint Agencies on development of alternatives. P-stage was used to identify areas that currently contain marbled murrelet habitat or that could develop into marbled murrelet habitat over the next five decades. P-stage was also used to estimate the potential impacts of habitat removal and potential mitigation of habitat retention and recruitment of each alternative. (Refer to Chapter 4 and Appendix H for a detailed description.)

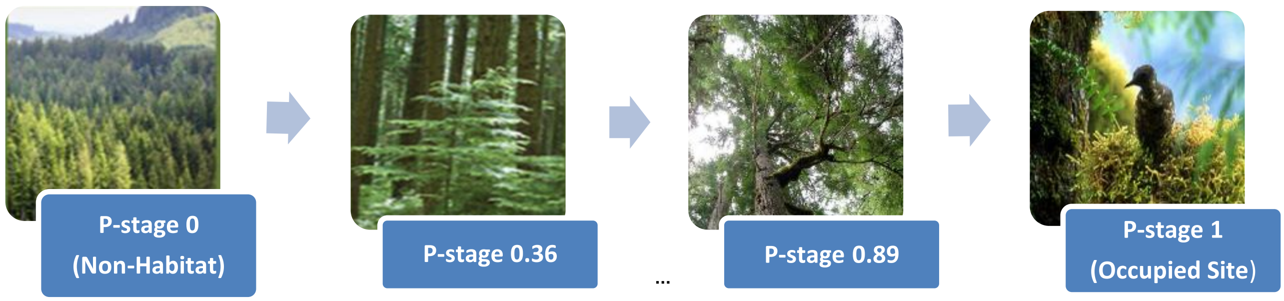
Text Box 2.1.2

What is the P-stage model?

The P-stage model, from the Science Team Report, classifies DNR-managed forestlands based on their relative value as nesting habitat, both now and into the future. The model uses DNR's forest inventory data (including forest type, stand origin, and stand age) to estimate the location and quality of murrelet habitat throughout the analysis area. Forestland is classified based on the probability it will be used for nesting by marbled murrelets. Among available habitat models, P-stage appears to work best for identifying current and future potential habitat on DNR-managed lands.

In general throughout this DEIS, when the term "marbled murrelet habitat" is used, this means land that has a P-stage value greater than zero (0). However, not every acre of DNR-managed land with a P-stage value is proposed for murrelet habitat conservation under the alternatives. Depending upon the alternative, certain forestlands with a P-stage value will be harvested over the life of the HCP. When designing the alternatives, the Joint Agencies considered P-stage value in concert with other information, such as proximity of the habitat to marine populations of marbled murrelets, potential for habitat fragmentation, proximity to mature forests that could provide additional security to potential nest sites, and location of neighboring conservation areas (for example, protected federal lands).

Figure 2.2.1. Ascending P-stage Classes and Associated Habitat Development



2.2 Elements Common to all Alternatives

The six alternatives (a no action alternative and five action alternatives) described in this chapter represent a range of different conservation approaches for the marbled murrelet. They do, however, share a common framework. All alternatives identify land for marbled murrelet conservation and apply conservation measures to that land. The elements common to all alternatives are described in this section.

■ How much land is designated for murrelet conservation?

Each alternative designates a different amount of land for conservation for the marbled murrelet, representing a range of options that are analyzed in this DEIS.

Table 2.2.1. Total Acres of Conservation by Alternative (rounded to nearest 1,000)

	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Acres of existing conservation that may provide benefits to marbled murrelets, depending on forest condition	583,000	583,000	583,000	583,000	583,000	583,000
Acres of additional, marbled murrelet-specific conservation[3]	37,000	10,000	53,000	51,000	57,000	151,000
Total approximate acres	620,000	593,000	636,000	634,000	640,000	734,000

These categories are explained in the next section.

[3] Acres reported here are those which do not overlap other existing conservation lands.

Lands providing existing conservation benefit to the marbled murrelet

Text Box 2.2.1

Do currently conserved lands provide habitat?

DNR-managed lands currently contain marbled murrelet nesting habitat that is conserved under the 1997 HCP or by other DNR policies. In addition, some DNR-managed lands contribute to murrelet conservation by increasing security forest or creating larger, more contiguous stands of structurally complex forest.

All alternatives include DNR-managed lands that are already deferred from harvest or otherwise conserved, meaning they are subject to existing policy or legal constraints and are excluded from variable retention harvest planning under the sustainable harvest calculation.[4] These lands are managed under specific strategies that also provide long-term habitat benefits to the marbled murrelet. The following management strategies and programs implemented by DNR provide existing conservation benefits to the marbled murrelet.

RIPARIAN CONSERVATION STRATEGIES

The 1997 HCP includes riparian conservation strategies to maintain or restore freshwater habitat for salmon on DNR-managed lands and aid in the conservation of other riparian and aquatic species. There are two strategies, one for the five west-side HCP planning units—the Riparian Forest Restoration Strategy (RFRS)—and another for the OESF. Both strategies establish riparian management zones on all salmonid-bearing streams and other streams of a certain size.[5] Both strategies specify the silvicultural treatments that can be used in riparian management zones (such as stand thinning) to speed the development of complex forests without sacrificing short-term ecosystem function. The main distinctions between the RFRS and OESF strategies is in how the riparian management zone is designed (in the RFRS, there is a set width by stream type, while the OESF uses a watershed analysis approach) and what the specific management objective is to be achieved (the RFRS has a desired future condition for all stands, while the OESF's objective is restoration of riparian function at the watershed scale). The other minor difference is that in the OESF, a small amount of area in the riparian management zone is allowed to be variable retention harvested. (For more information, refer to the OESF forest land plan.[6])

Riparian management zones in OESF and the other west-side HCP planning units are included as conservation lands in the alternatives analyzed in this DEIS because they are managed to maintain forest cover on a long-term basis. Forest stands in these zones can provide nesting habitat for marbled murrelets as well as insulate the habitat from other forest management activities.

OLD-GROWTH STRATEGY

The Board of Natural Resources' policy is to protect and defer timber harvests in all existing old growth on forested state trust lands in western Washington as part of implementing the HCP and meeting other regulatory requirements and policy goals.[7] Old-growth stands of 5 acres and larger that originated

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[4] The sustainable harvest calculation establishes the volume of timber to be scheduled for sale during a planning decade (RCW 79.10.300). Available at: www.dnr.wa.gov/shc

[5] *DNR Proprietary HCP Substitution Agreement for Aquatic Resources*, 2008, Appendix 1.

[6] Refer to www.dnr.wa.gov/oesf-forest-land-plan.

[7] *Policy for Sustainable Forest* (DNR 2006, p. 34).

naturally before 1850 and are in a fully functional stage of stand development are deferred from harvest, as are very large and structurally unique trees.[8] Old-growth stands provide the types of nesting platforms used by marbled murrelets and are therefore a critical part of the overall long-term conservation strategy.

NORTHERN SPOTTED OWL STRATEGY

The 1997 HCP also includes a landscape-scale strategy to protect and restore habitat for the northern spotted owl in strategic locations near the Cascades and on the west side of the Olympic Peninsula in the OESF. Northern spotted owl habitat and marbled murrelet habitat often overlap, as both species are associated with mature and old-growth forests. The conservation objective of the HCP northern spotted owl strategy in the five west-side planning units is to create habitat that significantly contributes to the species' demography, distribution, and habitat contiguity by providing provide nesting, roosting, and foraging (NRF) habitat as well as dispersal habitat in key areas. The northern spotted owl strategy for the OESF is to manage each landscape to maintain or restore threshold proportions of potential northern spotted owl habitat.

PROTECTION OF HABITAT FOR MULTIPLE SPECIES

The 1997 HCP is a multispecies document, and it employs additional strategies to ensure that uncommon habitats (such as large, structurally unique trees) are protected throughout the HCP planning units and to leave trees that are designated as part of harvest activities to maintain habitat and biodiversity.

NATURAL AREAS

These areas (briefly described in Chapter 1 and Chapter 3) often include mature forest habitat that is managed for long-term conservation for multiple species, including the marbled murrelet. Conservation, education, and low-impact recreation are some of the uses allowed in these areas, and harvest activities are generally not allowed.

OTHER CONSERVATION COMMITMENTS IN THE POLICY FOR SUSTAINABLE FORESTS

The *Policy for Sustainable Forests* (described in Chapter 1) provides for the identification and protection of genetic resources and special ecological features throughout the analysis area. These lands often contain marbled murrelet habitat or provide security forest functions or buffers to that habitat.

Table 2.2.2 provides a summary of the approximate number of acres providing existing multiple species conservation benefits within the analysis area. These lands form a general foundation of marbled murrelet conservation common among all the alternatives. Some of these lands may not be forested or contain marbled murrelet nesting habitat. But generally, when they are forested, they may contribute to murrelet conservation by providing security forest, or ideally, potential or future nesting habitat. These baseline acreage numbers are the same for each alternative, with the exception that Alternative F also includes low-quality northern spotted owl habitat. All acreage numbers are approximate based on current data from a variety of DNR databases.

[8] DNR Procedure 14-004-045.

Table 2.2.2. Acres of Currently Conserved Land Providing Benefit to the Marbled Murrelet (rounded to nearest 1,000; only non-overlapping acres are reported)

Type of conservation	Source	Approximate acres in long-term forest cover
Forested natural areas (Natural Area Preserves and Natural Resources Conservation Areas)	RCW 79.70, 79.71	85,000
Long-term conservation commitments for multiple species[9]	HCP, *Policy for Sustainable Forests*	479,000
Existing northern spotted owl habitat—high-quality[10]	HCP	19,000
Total		583,000

Marbled murrelet-specific conservation areas

Each alternative builds on the existing foundation of currently conserved lands described in the previous section by adding strategic conservation areas specifically for the marbled murrelet. These are generally referred to in the DEIS as "marbled murrelet conservation areas." These areas include occupied sites, buffers, special habitat areas, emphasis areas, marbled murrelet management areas, and other patches of high-quality habitat. The size of these different types of conservation areas ranges from the smallest of the existing occupied sites to the largest marbled murrelet management area. Each alternative designates one or more of these types of conservation areas, which are defined in the following sections.

OCCUPIED SITES

Occupied sites are areas previously identified through surveys as showing signs of occupancy by nesting murrelets (refer to Appendix D). Sites vary in size, depending on survey information, geographic location, and habitat quality. Alternative A uses those occupied sites that were identified during the survey effort from 1997 to 2002 as DNR implemented the interim strategy. Alternatives B through F use occupied sites that were expanded from this original set by the Science Team Report.

OCCUPIED SITE BUFFERS

Alternatives A and Alternatives C through F apply a 100-meter buffer to the outer extent of a mapped occupied site. Under Alternatives C through E, buffers are reduced to 50 meters for sites 200 acres or greater in size in the OESF planning unit. Alternative B does not apply any buffers to occupied sites.

[9] Includes mostly forested habitat, with a small amount of non-forested habitat such as balds, cliffs, caves, cultural sites, historic sites, and talus slopes. These conservation commitments also include leave tree areas, inoperable areas, old growth, eagle roosts, research plots, areas of local ecological importance, riparian areas, and forested wetlands.

[10] Existing northern spotted owl high-quality habitat refers to the following DNR mapped habitat classes as of 2015: old forest, high-quality nesting habitat, and A and B habitat per the definitions in the 1997 HCP (DNR 1997, p. 12).

HABITAT IDENTIFIED UNDER THE INTERIM STRATEGY

The 1997 HCP required that DNR identify higher-quality habitat types that would receive murrelet surveys to determine occupancy (DNR 1997, p. 40). This habitat was called reclassified habitat. All habitat found to be occupied by marbled murrelets is protected under the interim strategy, and the majority of the un-occupied, reclassified habitat is also protected. Some habitat was released for harvest under the criteria defined in the interim strategy. Alternative A designates habitat not released under the interim strategy as long-term forest cover (defined in the next section). No other alternative specifically protects reclassified habitat.

SPECIAL HABITAT AREAS

The goal of special habitat areas is to increase marbled murrelet productivity by reducing edge and fragmentation around occupied sites in specific geographic areas to benefit the species. All special habitat areas have at least one marbled murrelet-occupied site within their borders, and some have multiple occupied sites. Special habitat areas include not only the occupied site(s), but also surrounding habitat (P-stage) and non-habitat that may function as security forests. Security forest provides additional protection to nesting habitat from wind, predators, and other types of disturbances. Over the long term, additional marbled murrelet habitat is expected to develop in special habitat areas due to forest maturation.

Special habitat areas rely on the exclusion of active forest management to achieve the goal of reducing edge and fragmentation and growing new habitat over the long-term. Alternatives C, D, and E all designate special habitat areas, although the size and location of these areas varies by alternative (refer to Appendix F). Individual special habitat areas are smaller in size than emphasis areas or marbled murrelet management areas.

EMPHASIS AREAS

The goal of emphasis areas is to protect occupied sites, reduce fragmentation, and grow new habitat over the long term in specific geographic areas to benefit the species. The majority of emphasis areas have multiple occupied sites within their borders and thus are larger than special habitat areas. All emphasis areas provide a 0.5-mile buffer next to occupied sites where forest cover is maintained, improving and increasing the amount of security forest adjacent to the occupied sites. Emphasis areas also protect all existing habitat within their borders and have the goal of recruiting additional habitat, where the capability exists.

Emphasis areas allow some active forest management within their borders to achieve their goals. This includes both variable density thinning to facilitate the development of future habitat and variable retention harvest where it does not delay achieving future habitat goals for the emphasis area. Alternatives C and E designate emphasis areas.

MARBLED MURRELET MANAGEMENT AREAS

Marbled murrelet management area (MMMA) goals are to protect occupied sites and to increase future marbled murrelet nesting habitat within their borders. MMMAs are larger in size than either special habitat areas or emphasis areas. MMMAs are in geographic areas that will increase support for the species. MMMAs were originally designated in the Science Team Report, where maps of these areas for four of the six HCP planning units can be found. For this DEIS, MMMAs were added for North and South Puget planning units; refer to Appendix F. MMMAs allow thinning that facilitates recruitment of future marbled murrelet habitat. Only Alternative F designates MMMAs. Some management activities are allowed in these areas, consistent with habitat development and protection.

HIGH-QUALITY HABITAT STANDS

These are existing stands of P-stage habitat in class 0.47 or above that are protected. These stands are not otherwise identified as occupied sites or as part of the other conservation areas described in the preceding sections. Alternatives C and E designate these habitat stands for conservation in addition to special habitat areas and emphasis areas. Table 2.2.3 shows a comparison of acres by type of conservation area applied under the different alternatives. This table reports only those acres that are *additional* to the existing conservation provided by DNR.

Table 2.2.3. Approximate Acres of Marbled Murrelet-Specific Conservation, by Alternative (rounded to nearest 1,000)

Murrelet-specific conservation acres (2016)	Alternative A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Occupied sites	8,000	10,000	10,000	10,000	10,000	10,000
Occupied site buffers	12,000	n/a	13,000	13,000	13,000	16,000
Habitat identified under interim strategy	17,000	n/a	n/a	n/a	n/a	n/a
Marbled murrelet management areas	n/a	n/a	n/a	n/a	n/a	78,000
Emphasis areas	n/a	n/a	14,000	n/a	14,000	n/a
Special habitat areas	n/a	n/a	9,000	28,000	13,000	n/a
High-quality P-stage habitat (≥0.47) patches	n/a	n/a	7,000	n/a	7,000	n/a
Existing northern spotted owl habitat—low-quality[11]	n/a	n/a	n/a	n/a	n/a	47,000
Total	**37,000**	**10,000**	**53,000**	**51,000**	**57,000**	**151,000**

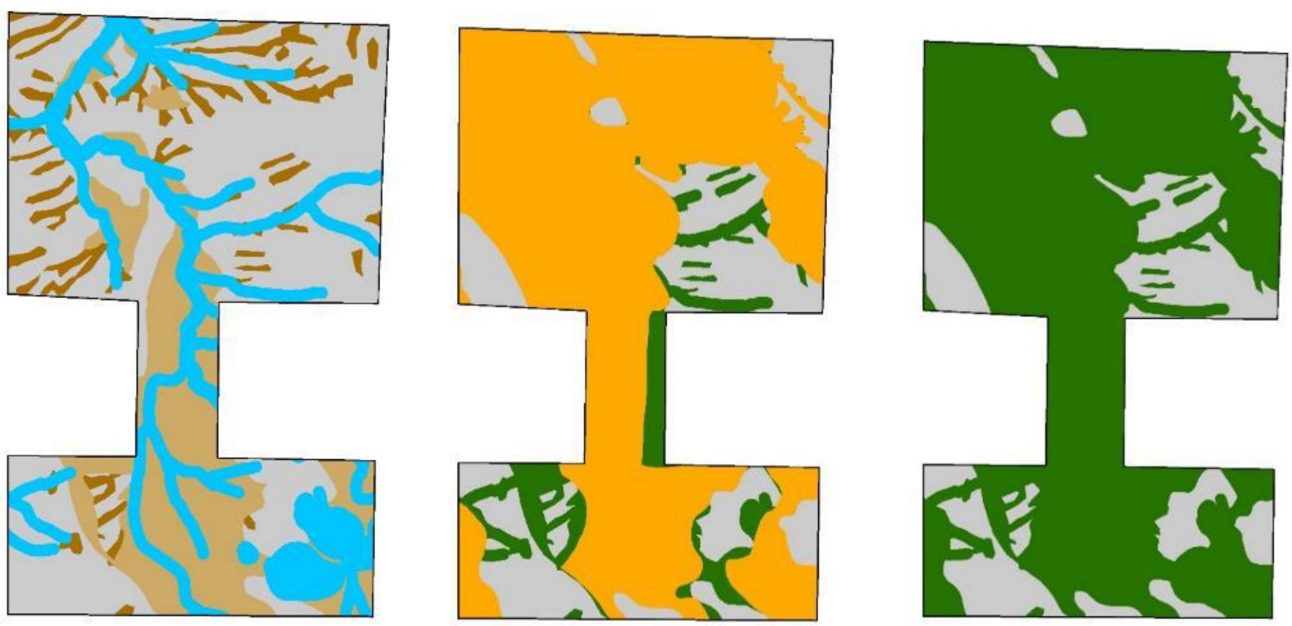
Acres reported are only those which do not overlap the existing conservation commitments reported in Table 2.2.2.

[11] Existing northern spotted owl high-quality habitat refers to the following DNR-mapped habitat classes as of 2015: old forest, high-quality nesting habitat, and A and B habitat per the definitions in the 1997 HCP (DNR 1997, p. 12).

Putting it all together: Long-term forest cover

The combination of lands that provide marbled murrelet conservation through existing DNR policies (for example, riparian zones), plus marbled murrelet-specific conservation areas, provides a network of long-term forest cover (LTFC) for the murrelet on DNR-managed lands. By long-term forest cover, we mean lands where variable retention harvest is not allowed and that will remain forested through the life of the HCP, providing murrelets with nesting habitat or security for that habitat. (Refer to Figure 2.2.2 and Appendix G for a more detailed description of LTFC.) The conservation lands included in LTFC often overlap (refer to Figure 2.2.2). For example, some acres of high-quality owl habitat may also be within a special habitat area. Summary data provided throughout the DEIS does not double-count these overlapping acres for purposes of assigning take or mitigation or analyzing impacts. It is important to note that the amount of LTFC that is mapped now may change over time as field inspections more accurately map lands in some categories. It expected that these potential changes would not be significant.

Figure 2.2.2. Illustration of Different Components of LTFC on a Block of DNR-Managed Land



Existing conservation areas: riparian (blue), steep slopes (brown), owl habitat (light brown)

+ Marbled murrelet-specific conservation areas (orange) layered on top of existing conservation

= Long-term forest cover (green)

Figure 2.2.2 illustrates this important LTFC concept. For example, assume that the total DNR-managed acreage within the left map is 1,000 acres. The left map further identifies 200 acres in riparian areas, 100 acres in steep slopes, and 100 acres in owl habitat. The map in the center then adds 300 acres of marbled murrelet-specific conservation, much of which overlaps these other areas. The map on the right combines all the different LTFC designations, for a total of 700 acres of LTFC within the 1,000-acre block of DNR-managed land.

■ Do the alternatives include new conservation measures to protect the marbled murrelet?

A variety of management and land use activities occur on DNR-managed forestlands, including lands within LTFC. Some of these activities have the potential to negatively impact the marbled murrelet or its nesting habitat.

Certain impacts to marbled murrelets can be classified as incidental take. Under the ESA, the definition of take includes harm to a listed species.[12] The ESA's implementing regulations define harm to include "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (50 CFR 17.3). Incidental take as defined under the ESA regulations is take of a listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity. The harvest of marbled murrelet habitat is an example of incidental take. One approach to mitigate incidental take can be to provide habitat in other locations that offsets it temporally and spatially. The USFWS is responsible for conducting a detailed analysis of the take and mitigation prior to issuing an incidental take permit.

Existing and ongoing activities, such as use of recreation facilities and existing forest roads, are expected to continue throughout LTFC, as defined in the 1997 HCP. The Joint Agencies conducted an analysis of common, ongoing forest management activities and incorporated a level of "disturbance take" into the take and mitigation framework for the long-term conservation strategy (refer to Appendix H: Potential Impacts and Mitigation focus paper).

The Joint Agencies also identified new, intensified, or expanded forest management activities that could create new impacts to marbled murrelets through the life of the HCP, including disturbing the birds during nesting and breeding season. To address these potential impacts, the action alternatives propose new conservation measures. Most conservation measures apply specifically to marbled murrelet conservation areas. Where other HCP strategies, DNR requirements or policies, or state law also apply to LTFC, the most restrictive requirement will be followed (refer to Figure 2.2.3 in the following section).

Text Box 2.2.2

What activities occur on DNR-managed lands?

A variety of activities and land uses occur on the 1.377 million acres of DNR-managed forestlands in the analysis area. These include but are not limited to:

- Timber management and timber harvest
- Road building and maintenance
- Forest health treatments and salvage
- Wildfire control
- Passive and active recreation (hiking, biking, camping, hunting and fishing, off-road vehicle use)
- Leases for exploring valuable minerals and energy sources
- Development of utilities transportation corridors
- Tribal and cultural uses including collection of timber and non-timber products
- Research

The Joint Agencies took these many diverse activities and uses into account when designing conservation measures to reduce impacts to marbled murrelets.

[12] 16 U.S.C. §1532(19).

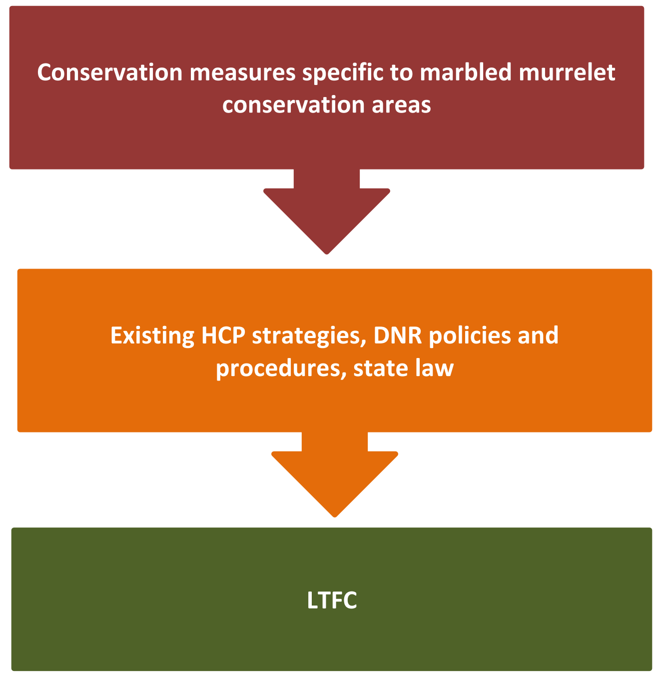
Alternative A, the no action alternative, does not include these proposed new conservation measures. Management and land use activities under Alternative A would instead be governed by the existing management strategies in the 1997 HCP.

Proposed conservation measures (action alternatives)

The following conservation measures are common to all the action alternatives, with some variation where noted in the sections that follow. The measures address activities that are most likely to cause impacts to nesting murrelets or their young, including activities that could attract predators or activities that generate noise.

For purposes of these conservation measures, **the nesting season is defined as April 1 through September 23.** Daily timing restrictions are used to minimize potential impacts of an activity during daily peak activity periods for the murrelet during this nesting season. The daily timing restrictions are one hour before official sunrise to two hours after official sunrise and from one hour before official sunset to one hour after official sunset.

Figure 2.2.3. Hierarchy of Requirements Applicable to Long-Term Forest Cover



HARVEST AND HARVEST-RELATED INFRASTRUCTURE AND FOREST MANAGEMENT

Harvest. Timber harvest activities in areas identified as long-term forest cover will be consistent with the specific management objectives of those lands. Those objectives are defined by the conservation strategy applicable to the land (for example, the Riparian Forest Restoration Strategy or old-growth strategy). Variable retention harvest will be prohibited in occupied sites and their buffers, within special habitat areas, within 0.5 mile of occupied sites in emphasis areas, MMMAs (consistent with the Science Team recommendations for the OESF), and within other blocks of high-quality habitat identified by an alternative. Where different strategies overlap, the most restrictive requirement will apply, as illustrated in Figure 2.2.3.

Thinning and related silviculture. Thinning and silviculture prescribed by an underlying plan or policy, such as the HCP riparian strategies, OESF forest land plan, or natural areas management plans, will continue if these areas are not otherwise part of a designated marbled murrelet conservation area. Some thinning and silviculture may be allowed in marbled murrelet conservation areas where those activities are consistent with maintaining murrelet nesting habitat and providing security forest.[13] Specific measures

[13] For the purposes of this DEIS, security forest is defined as closed-canopy stands over 80 feet tall.

for thinning and silviculture are summarized in Table 2.2.4 and are described under each alternative profile in the next section.

Table 2.2.4. Thinning Requirements in Long-Term Forest Cover (LTFC)

Element of LTFC	LTFC outside of emphasis areas, special habitat areas, and MMMAs	Emphasis areas	Special habitat areas	MMMAs
Occupied sites	Not allowed	Not allowed	Not allowed	Not allowed
Occupied site buffers	Allowed: Riparian Forest Restoration Strategy (RFRS) – Type III or OESF variable density thinning or pre-commercial thinning allowed as needed to enhance or maintain security forest with windfirm canopy	Allowed if needed to enhance or maintain security forest with windfirm canopy	Not allowed	Allowed: Commercial thinning or habitat enhancement thinning with objective to enhance habitat or maintain canopy cover
0.5-mile buffer around occupied sites	n/a	RFRS-Type III or OESF variable density thinning allowed to enhance habitat development or maintain canopy cover	n/a	n/a
Current P-stage habitat	Not allowed	Not allowed	Not allowed	Not allowed
Future P-stage habitat and non-habitat	Allowed	Allowed	Not allowed	Allowed
Unstable slopes	Allowed consistent with geologic assessment	Allowed consistent with geologic assessment	Not allowed	Allowed consistent with geologic assessment
Riparian areas	Allowed consistent with riparian strategies	Allowed consistent with riparian strategies	Not allowed	Allowed consistent with riparian strategies

Element of LTFC	LTFC outside of emphasis areas, special habitat areas, and MMMAs	Emphasis areas	Special habitat areas	MMMAs
Northern spotted owl (NSO) habitat	Allowed only in low-quality habitat consistent with NSO objectives; in high-quality habitat, not allowed consistent with 1997 HCP (refer to Table 2.4.1 for definitions)[14]	Allowed only in low-quality habitat consistent with NSO objectives; in high-quality habitat, not allowed consistent with 1997 HCP	Not allowed	Allowed only in low-quality habitat consistent with NSO objectives; in high-quality habitat, not allowed consistent with 1997 HCP
NAPs	Allowed consistent with NAP management plan	Allowed consistent with NAP management plan	Not allowed	Allowed consistent with NAP management plan
NRCAs	Allowed consistent with NRCA management plan	Allowed consistent with NRCA management plan	Not allowed	Allowed consistent with NRCA management plan

Forest health treatments. Forest health treatments to deal with root rot, pests, and fire damage will be allowed throughout LTFC in accordance with site-specific management plans and state law. Daily timing restrictions during the nesting season will be followed, and prescribed burning will be kept greater than 0.25 miles from occupied sites.

Forest roads. DNR builds and maintains a network of forest roads throughout LTFC, providing access to harvestable timber stands. These roads are also used by recreation users for hiking, motorized and non-motorized use, and access to fishing, hunting, and camping sites. Forest roads create forest edges, which can attract common predators of murrelet eggs and young, including Steller's jays and other corvids. Use of forest roads by motorized vehicles may also cause noise disturbance to nesting murrelets. Use of existing forest roads is covered by the 1997 HCP. Construction of new forest roads in marbled murrelet conservation areas would be subject to one of two conservation measures as shown in Table 2.2.5.

[14] Thinning is allowed within high-quality spotted owl habitat in the OESF.

Table 2.2.5. Forest Road Conservation Measures

Activity/Use	Alternatives B, E, and F	Alternatives C and D
New road construction and reconstruction	Avoiding impacts to murrelet habitat resulting from road construction or reconstruction through special habitat areas, MMMAs, occupied sites and their buffers, including the 0.5-mile buffer around occupied sites within emphasis areas is the first priority. If potential impacts from road construction or reconstruction are identified in these areas, and DNR decides to pursue the road construction or reconstruction project, USFWS and DNR will consult and condition the project to avoid, minimize, or mitigate as necessary, subject to state and federal laws governing the activity or emergency (e.g., culvert or bridge replacement). This consultation[15] may result in some road construction through murrelet conservation areas, including occupied sites.	No new road construction or reconstruction through special habitat areas, occupied sites and their buffers, including the 0.5-mile buffer around occupied sites within emphasis areas unless otherwise required by state or federal laws or emergency (for example, a culvert or bridge replacement).

Maintenance, decommissioning, and abandonment of roads within 100 meters of an occupied site must follow daily timing restrictions if the activity takes place within the nesting season.

Harvest-related infrastructure. The building and installation of infrastructure needed for harvest activities are prohibited in special habitat areas and are limited in other marbled murrelet-specific conservation areas as follows:

- Tailholds and rigging must be installed outside the nesting season if they will be in occupied sites. Impacts to platform trees and trees adjacent to platform trees must be avoided.
- Guy lines and landings should be avoided; otherwise, these should be installed outside the nesting season or follow daily timing restrictions if during nesting season. This activity will minimize removal of large trees or platform trees and will require approval by the DNR regional manager. (Best management practices and mitigation may be required, as provided for in the Riparian Forest Restoration Strategy, for example.)
- Yarding corridors should be located outside occupied sites unless no other route is feasible. If a corridor through an occupied site is deemed necessary, DNR will consult with USFWS.

Salvage and recovery. Sometimes, natural disturbance events such as a wind event can result in forest stands being blown down. Salvage and restoration within marbled murrelet-specific conservation areas may occur under the proposed alternatives, if such action will contribute to the recovery of nesting habitat or security forest. Salvage or recovery will require a site-specific restoration plan approved by DNR

[15] As used throughout these conservation measures, "consultation" refers to a joint agency agreement process, and not consultation under ESA Section 7.

region with wildlife biologist input. Salvage must take place outside the nesting season when feasible. When not feasible, the activity will follow daily timing restrictions. If standing platform trees must be removed, DNR will consult with USFWS. DNR may conduct reforestation or regeneration activities after salvage with the goal of habitat restoration. These activities may include silvicultural treatments (such as site preparation and vegetation management).

NOISE-GENERATING ACTIVITIES

In 2013, USFWS published a biological opinion (USFWS 2013) that contained an analysis of noise-generating activities with the potential to disturb or disrupt nesting marbled murrelets. The action alternatives were designed with consideration of the analytical approach used in the 2013 biological opinion and include the following conservation measures as a result.

Blasting. Impulsive noise can negatively impact murrelets (USFWS 2013), by affecting the hearing of the young or adults and/or disrupting normal nesting behaviors. Blasting of hard rock materials occurs throughout DNR-managed lands, associated either with DNR's own rock pits (sources of material for road building and maintenance), road construction activities, or with resource extraction from leased pits. Two different conservation measures are proposed to address potential impacts from blasting in long-term forest cover:

Table 2.2.6. Conservation Measures to Address Blasting Impacts

Activity/Use	Alternatives B, E, and F	Alternatives C and D
Blasting (associated with forest road construction, maintenance, or extraction of valuable materials)	If blasting is needed during the nesting season within 0.25 mile of occupied sites, special habitat areas and within the 0.5-mile buffer of occupied sites within emphasis areas, DNR will consult with USFWS to avoid, minimize, and mitigate impacts to murrelet nests.	During the nesting season, blasting is prohibited within: • special habitat areas, • the 0.5-mile buffer of occupied sites within emphasis areas, and • 0.25 mile of occupied sites.

Crushing and pile-driving. For crushing or pile-driving within 110 meters (120 yards) of occupied sites, crushing activities shall take place outside the nesting season when feasible; if the activity must take place during the nesting season, it must follow daily timing restrictions.

Aerial activities. Low-flying airplanes and helicopters are used for a number of activities in or adjacent to marbled murrelet conservation areas, including aerial spraying of herbicides or fertilizers to prepare sites or manage vegetation, helicopter logging operations, maintenance of communication towers, and road and trail maintenance such as bridge replacement. Under some circumstance, aircraft overflights can disrupt the normal nesting behaviors of marbled murrelets. To reduce the likelihood of those potential impacts, the action alternatives apply the USFWS recommended disturbance distance buffers during the nesting season from occupied sites, special habitat areas, and the 0.5-mile buffer of occupied sites in emphasis areas as follows:

- Helicopters—Chinook 47d: 265 yards or less
- Helicopters—Boeing Vertol 107, Sikorsky S-64 (SkyCrane): 150 yards or less
- Other small helicopters and fixed-wing aircraft: 110 yards or less

Aerial application of herbicides will follow daily timing restrictions during the nesting season.

RECREATION

A wide variety of recreational activities occur on DNR-managed lands. Existing recreation is covered under the HCP as a *de minimis* use, and DNR regularly consults with USFWS for new activities that could potentially impact murrelet habitat. The action alternatives propose two approaches to avoiding and minimizing the impacts from *new or expanded* recreation activities for the murrelet as follows:

Table 2.2.7. Conservation Measures to Address Recreation Impacts

Activity/Use	Alternatives B, E, and F	Alternatives C and D
Recreation facilities, trails and leases. Includes new or expanded facilities, such as campgrounds, day use areas, sno-park sites, and trailheads; new or expanded motorized trails; and new or expanded non-motorized trails.	All proposed new or expanded recreation facilities, trails, and recreational leases in special habitat areas and MMMAs occupied sites and their buffers, including the 0.5-mile occupied site buffer within emphasis areas will be evaluated by DNR for potential murrelet habitat impacts, including potential removal of nesting habitat and disturbance to nesting birds from facility or trail development or use in these areas. If impacts are identified, and DNR decides to pursue these activities, DNR will consult with USFWS. Facility or trail siting and design may be restricted or conditioned by the agencies to avoid, minimize, and mitigate murrelet impacts. Routine maintenance, as well as maintenance and improvements to facilities and trails located in these areas is allowed to deal with health, safety, or environmental issues. Illegal facilities and trails may be decommissioned or abandoned within murrelet habitat. All construction, decommissioning, and maintenance activities within occupied sites, buffers, special habitat areas, or MMMAs shall follow daily timing restrictions during the nesting season, or take place outside the nesting season when feasible.	No development of any new or expanded recreation facilities, trails, and recreational leases in special habitat areas, occupied sites, and their buffers, including the 0.5-mile occupied site buffer within emphasis areas. Prohibit conversion of any existing non-motorized trails to motorized use within those areas. DNR, in consultation with USFWS, may decommission or abandon illegal trails in these areas. Maintenance or improvements within the footprint of existing facilities, trails, and recreational leases within special habitat areas, emphasis areas, and occupied sites and buffers (including upgrades to deal with health and safety or environmental damage) would be allowed. These activities should take place outside the nesting season, or following daily timing restrictions during the nesting season.

OTHER NON-TIMBER HARVEST LAND USES

In addition to the activities described in the preceding sections, DNR-managed lands accommodate uses that have the potential to result in impacts to nesting murrelets or removal of potential murrelet habitat. For all action alternatives, the following conservation measures are proposed to avoid, minimize, and mitigate potential impacts from these activities.

Easements and rights-of-way: DNR grants easements and rights-of-way for federal and non-federal projects (for example utility corridors, public roads, private road access to inholdings). Existing easements are subject to the conditions of their contracts and the 1997 HCP and are not affected by the alternatives in this DEIS. The action alternatives propose language to the HCP clarifying that federal projects must follow NEPA, including required consultation with USFWS and the National Marine Fisheries Service under the ESA, and may include avoidance, minimization, and mitigation by the proponent if necessary. For non-federal projects, DNR will avoid siting new powerlines and utilities in marbled murrelet habitat when feasible, subject to laws requiring DNR to grant interests in real property or use of state lands. New utilities will follow existing roads when feasible.

Leases and contracts. DNR grants leases, contracts, and special use permits on its lands to external parties for a variety of activities, including valuable materials sales, oil and gas exploration, mining and prospecting, communications facilities, and other special uses. Existing contracts and leases are subject to the conditions of their contracts and the 1997 HCP and are not affected by the alternatives in this DEIS. Many leases are discretionary, and some are required by other federal or state laws. For all proposed new or renewed leases or contracts on lands located within special habitat areas, 0.5 mile of occupied sites in emphasis areas, and occupied sites, avoiding impacts resulting from these activities is the first priority. If potential impacts are identified in these areas, and DNR decides to pursue the proposal, USFWS and DNR will consult to design conditions of the lease or contract to consider strategies for avoidance, minimization, or mitigation as necessary, subject to state and federal laws governing the activity. Noise-generating activities will comply with disturbance distance thresholds and timing restrictions detailed in this section, where feasible.

Land dispositions. No voluntary disposition of land involving murrelet conservation areas (occupied sites, marbled murrelet management areas, special habitat areas, or emphasis areas) will be allowed without retaining HCP conservation commitments. Dispositions without retaining HCP conservation commitments will be avoided elsewhere in LTFC.

Research. Non-invasive research will be allowed in LTFC, following daily timing restrictions during nesting season. Invasive activities (those causing prolonged audiovisual disturbance or involving heavy equipment) must occur outside the nesting season within LTFC.

Emergency operations. All fire suppression activities, including aerial fire operations and aircraft, are allowed in LTFC, following "minimum impact suppression tactics" guidance.[16]

OTHER FOREST MANAGEMENT ACTIVITIES

For activities not listed in this section, DNR follows the existing language of the HCP and will consult with USFWS where necessary to avoid, minimize, and mitigate impacts of the activity.

[16] Refer to *NWCG Guidance on Minimum Impact Suppression Tactics*, 2003.

■ How will new conservation measures be applied to lands already managed under an existing HCP strategy, law, or policy?

Management of lands already deferred from harvest or otherwise conserved will generally continue under their governing laws, policies, and management strategies as described earlier in this chapter. The 1997 HCP defines what levels of activity are *de minimis* or otherwise how the activity is covered by the HCP (1997 HCP, Ch. IV, Section H). Under Alternative A, the no action alternative, the current HCP and subsequent concurrence letters (refer to Appendix I) define how forests are managed for conservation purposes. DNR frequently consults with USFWS on management activities that could impact murrelet habitat.

If, as described in the preceding section, a marbled murrelet conservation area with special conservation measures overlaps one of these existing deferred lands, then the most restrictive measure will apply. If, for example, a new road would be allowed through a riparian zone in accordance with the Riparian Forest Restoration Strategy but there is a restriction on road building through an occupied site within that riparian zone (as in Alternatives C and D), then road building would avoid that occupied site. Conversely, if some riparian harvest is allowed under the RFRS, and the land is not otherwise designated as murrelet habitat, the harvest may proceed, with mitigation provided.

■ What happens outside LTFC?

Forestlands outside LTFC will continue to be managed per DNR policy and rule, including the 1997 HCP, Sustainable Harvest Calculation, Forest Practice Rules, HCP riparian strategies, and other state and federal laws (refer to Chapter 1). Once the Board of Natural Resources approves an HCP amendment that will include a long-term marbled murrelet conservation strategy, DNR will apply for an incidental take permit from USFWS. If approved, and all permit terms are accepted, all DNR-managed lands within the planning area will be subject to the incidental take permit. Any harvest of murrelet habitat in areas outside of LTFC will be considered potential incidental take that is mitigated by P-stage habitat within LTFC (now and in the future) and other marbled murrelet-specific conservation approaches through the life of the HCP. Section 2.4 and Chapter 4 summarize potential impacts and mitigation expected under each alternative.

Text Box 2.2.2

Is all forestland outside LTFC subject to harvest?

Not necessarily. The sustainable harvest calculation (refer to Chapter 1) determines the harvest level for lands that are not otherwise deferred by state law or DNR policy, including the 1997 HCP. There are many constraints to harvest, including policies that protect old-growth forests, require hydrologic maturity, or protect habitat for other species. Operational costs also play a factor in where and when a harvest will occur.

2.3 Profiles of the Alternatives

The purpose of this section is to describe each alternative in detail. Descriptions will focus on the location, composition, distribution, and quality of marbled murrelet conservation among the HCP planning units in the analysis area.

■ Location

Maps showing where long-term forest cover is located, as well as the location of any murrelet-specific conservation areas (for example, special habitat areas), are provided at the analysis area scale in the following section and in Appendix F for each planning unit or at smaller scales where necessary. The maps provided in this sections are created using DNR geographic information system (GIS) data from 2015. The polygons drawn to represent the boundaries of long-term forest cover are based on the best estimates of the location of these areas for purposes of environmental analysis. These maps are built with the expectation that the final marbled murrelet long-term conservation strategy that the Board adopts, and is then evaluated by USFWS for HCP amendment, will include more precisely refined polygons.

■ Composition, distribution, and quality

Opportunities for contributing to marbled murrelet conservation vary among HCP planning units. Each planning unit is a different size, has different amounts of DNR-managed forestland, and contains different amounts of marbled murrelet habitat. The OESF and North Puget planning units contain the most acres of land contributing to marbled murrelet conservation. However, land contributing to marbled murrelet conservation occurs in all planning units. The distribution of marbled murrelet conservation is described for each alternative in the following sections. Differences among the planning units can be attributed to differences in the amount of available habitat, importance of specific geographic areas for long-term marbled murrelet conservation, proximity to federal lands, existing occupied sites and off-shore marbled murrelet populations, and the location of state trust lands. Long-term forest cover includes both habitat (forested areas with a P-stage value) and non-habitat. Non-habitat might be young or immature forest that may not develop into nesting habitat through the life of the HCP, but still provides security to nesting habitat by buffering interior forest stands from predation, wind, and other disturbances. Some areas of non-habitat in the first decade of the HCP will mature into habitat by the final decade of the HCP. The quality of habitat (measured by P-stage value) also improves over time within LTFC. Under every alternative, more nesting habitat becomes available through the life of the HCP.

Text Box 2.3.1

Does more habitat develop over time?

Under every alternative, more and higher-quality nesting habitat becomes available through the life of the HCP as forests grow and mature within LTFC.

Alternative A

Alternative A is the no action alternative. It continues DNR operations as authorized under the 1997 HCP and incidental take permits for all of the west-side planning units. It conserves habitat identified under the HCP interim strategy and also continues implementation of the 1997 HCP as described in subsequent joint concurrence letters for marbled murrelet conservation. This alternative includes approximately **620,000** acres of LTFC, with specific murrelet conservation lands including:

- All HCP-surveyed occupied sites, with a 100-meter buffer
- All reclassified habitat in the Olympic Experimental State Forest (OESF)
- All reclassified habitat in the Straits, South Coast, and Columbia planning units that has not been identified as "released" for harvest under the interim strategy
- In the North Puget and South Puget planning units, all suitable habitat that has not been identified as "released" for harvest subject to the 2007 and 2009 concurrence letters, all newly identified habitat, and all potential habitat that has a P-stage value greater than 0 in Decade 0.[17] Refer to the following section for further information on this habitat.

How is murrelet habitat defined under the interim strategy?

Depending on the planning unit, the interim strategy identifies areas of "reclassified habitat" and "potential" or "suitable habitat" for marbled murrelet conservation. For the four westernmost planning units, habitat types were designated based on habitat relationship studies where DNR collected a wide variety of forest data from 54 study plots located in stands with a range of habitat quality characteristics. DNR then surveyed each of these plots to determine which were occupied by marbled murrelets and used that relationship between forest characteristics and occupancy to predict occupancy across the west side.

In the North and South Puget planning units, the model did not accurately predict these areas. An alternative approach was developed by the Joint Agencies in 2007 and 2009 in "concurrence letters" that established a process to identify and manage potential and suitable habitat in North and South Puget planning units. The next section and Appendix D further describe the steps DNR follows to identify habitat among all the planning units under the interim strategy. Table 2.3.1 provides a summary of marbled murrelet conservation acres under Alternative A.

[17] P-stage was not used under the 1997 HCP to identify habitat. To allow Alternative A to be compared with the action alternatives, the P-stage model was applied to North and South Puget planning unit habitat to approximate the suitable habitat located in these planning units.

Table 2.3.1 Marbled Murrelet-Specific Conservation Acres—Alternative A[18]

Type of conservation area	Acres (estimated)
Occupied sites	8,000
Occupied site buffers	12,000
Habitat identified under the interim strategy	17,000
Total acres	37,000

Forest management under the no action alternative

Timber harvest in and adjacent to occupied sites is limited under the no action alternative, but these limits vary by HCP planning unit. Common elements to all HCP Planning Units include:

- Harvest is deferred from all HCP-surveyed occupied sites.
- 100-meter buffers are applied to all occupied sites.
- Daily timing restrictions may be applied for forest management activities during the critical nesting season adjacent to all occupied sites. (These are evaluated on a case-by-case basis.)
- Forests in OESF will be managed under the OESF forest land plan.

SOUTHWEST WASHINGTON, THE OLYMPIC EXPERIMENTAL STATE FOREST, AND THE STRAITS PLANNING UNIT

All reclassified habitat within the Olympic Experimental State Forest (OESF) and Southwest Washington, defined as those portions of the Columbia and South Coast planning units west of Interstate 5 and that portion of the South Coast planning unit south of Highway 8 and south of Highway 12 between the towns of Elma and Aberdeen, is deferred from harvest. Reclassified habitat in Straits, the northwestern portion of South Coast, and the far eastern portion of the Columbia planning unit *is* available for harvest if 50 percent of the habitat will remain within the watershed administrative unit (WAU) and if the habitat is greater than 0.5 mile from an occupied site.

NORTH AND SOUTH PUGET PLANNING UNITS

The 2007 and 2009 concurrence letters between USFWS and DNR (Appendix I) establish a stepwise process for how murrelet habitat is managed in the North and South Puget planning units. Habitat meeting the definition of "suitable habitat," but which has not been surveyed for marbled murrelet presence, is deferred from harvest. Suitable habitat is defined as a forested area 5 acres in size or larger with at least two platforms per acre and within 50 miles of marine waters.

All un-surveyed suitable habitat is protected with a 300-foot managed buffer, or a 165-foot no-touch buffer until surveys are complete.[19] Once surveys are complete, buffers and timing restrictions on forest management activities are

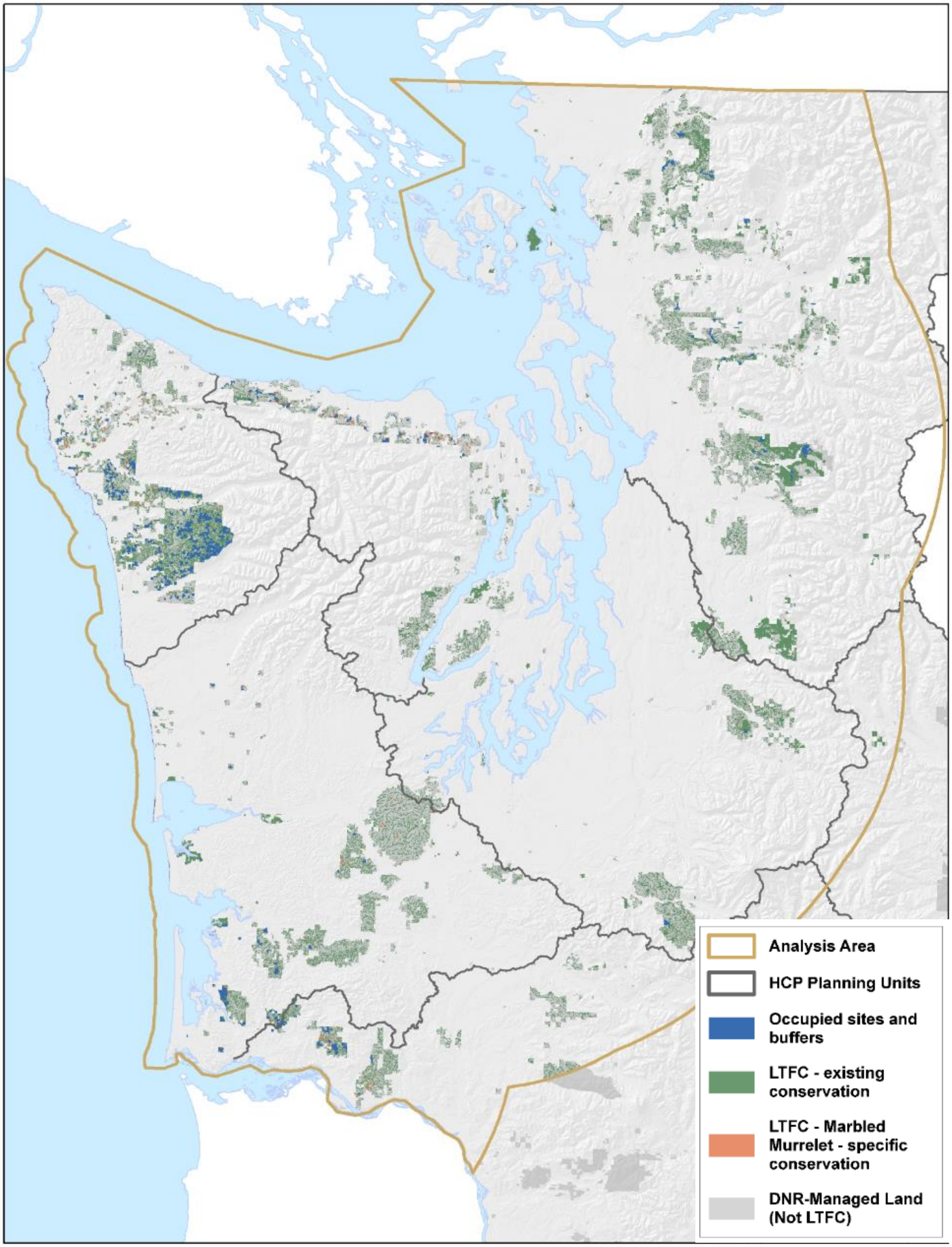
[18] Note that the acres reported here, and in similar tables for each alternative profiled in this section, are only those acres that do not overlap with existing conservation under the 1997 HCP or other DNR conservation commitments.

[19] WAC 222-16-080(1)(j)(v).

not required for areas found to be unoccupied by murrelets. Surveyed suitable habitat within the North Puget planning unit can be released for harvest if 50 percent of the habitat will remain within the WAU, and if the habitat is greater than 0.5 mile from an occupied site.

All new forest management activities screen project areas to locate and conserve newly identified suitable habitat. Newly identified suitable habitat is managed slightly different from known suitable habitat. Prior to adoption of a long-term strategy, any newly identified suitable habitat will not require buffers or harvest timing restrictions. Unique to the North Puget planning unit, limited road construction or yarding corridors are allowed within low-quality, newly identified suitable habitat if, after survey, the site is not found to be occupied.

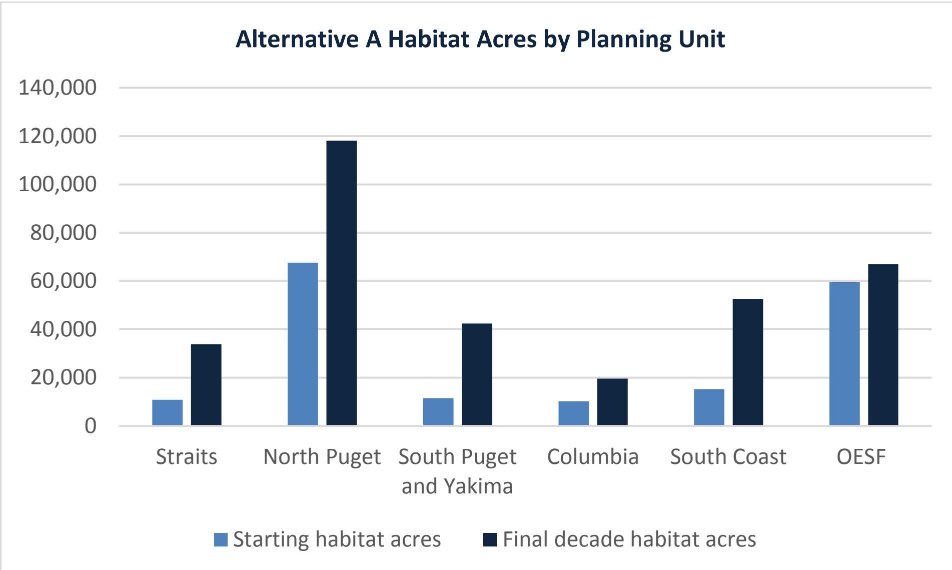
Figure 2.3.1. Habitat Location—Alternative A



Habitat composition and distribution

Figure 2.3.2 depicts the growth of habitat (acres of land with a P-stage value) within LTFC at the beginning of the planning period (2015) compared with the final decade of the planning period (beginning 2057). The figure also illustrates the distribution of habitat acres among the planning units.

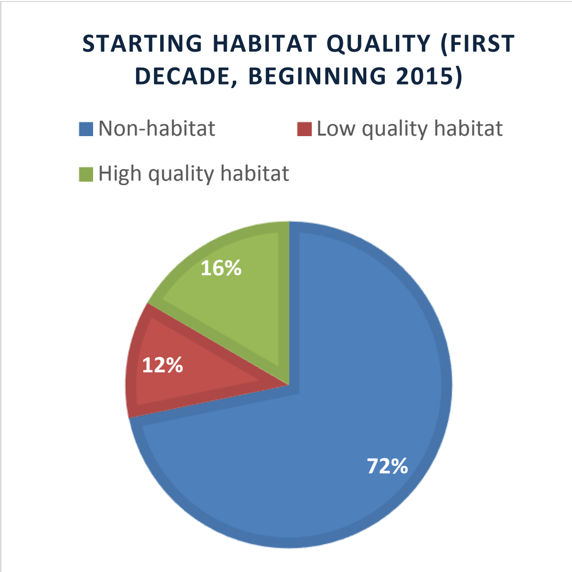
Figure 2.3.2. Habitat Growth by Planning Unit—Alternative A

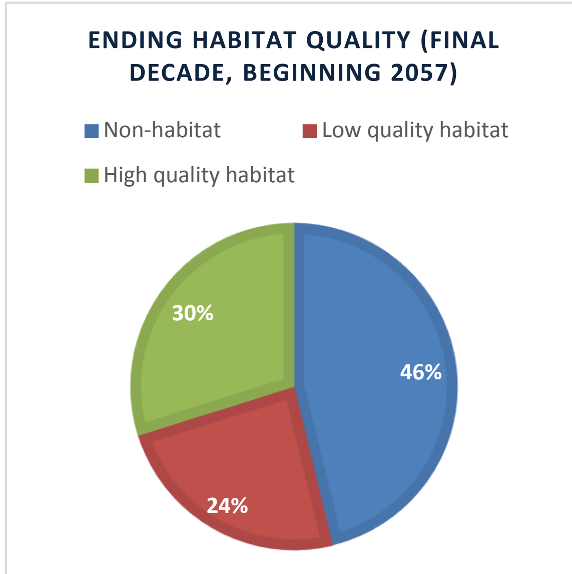


Habitat quality in LTFC

Habitat quality increases among different P-stage categories throughout the planning period. Most of the increase in habitat quality comes from land starting with a P-stage value of zero (0, meaning non-habitat) in 2015 developing into low-quality habitat (P-stage values of 0.25 to 0.36) by the end of the planning period. High-quality habitat (P-stage value 0.47 to 1) also increases over time. Figure 2.3.4 shows habitat quality as a percentage of LTFC. Each alternative has a different amount of LTFC acres, so percentages are relative to those acres.

Figure 2.3.4. Starting and Ending Habitat Quality—Alternative A





Alternative B

Alternative B focuses on protecting the known locations of marbled murrelet-occupied sites on DNR-managed lands. Under this alternative, long-term forest cover totals approximately **593,000** acres and includes occupied sites delineated by the Science Team recommendations, as well as occupied sites identified by DNR staff in the North and South Puget planning units. This alternative is the only one that does not provide buffers on occupied sites. Harvest and thinning would be prohibited in occupied sites.

Table 2.3.2. Marbled Murrelet-Specific Conservation Acres—Alternative B

Type of conservation area	Acres (estimated)
Occupied sites	10,000[20]

Habitat composition and distribution

Figure 2.3.5. Habitat Growth by Planning Unit—Alternative B

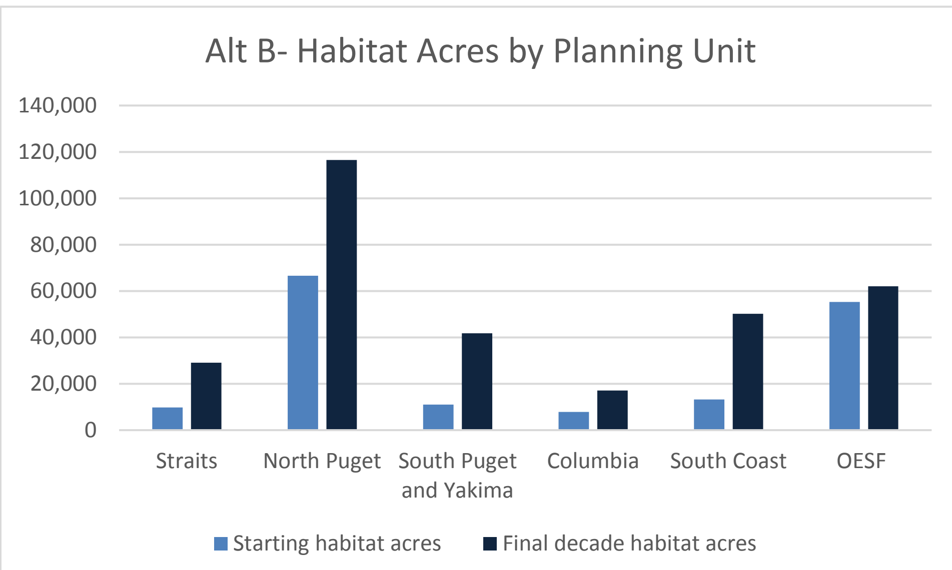


Figure 2.3.5 depicts the growth of habitat (acres of land with a P-stage value) within LTFC at the beginning of the planning period (2015) compared with the final decade of the planning period (beginning 2057). The figure also illustrates the distribution of habitat acres among the planning units. Although Alternative B contains the lowest total number of acres in LTFC among the alternatives, the amount of habitat conserved still increases over time, particularly in North Puget and South Coast planning units.

[20] Note: Alternative B and all action alternatives add approximately 16,000 acres of occupied sites compared with the no action alternative. However, only the portion of these acres are not already conserved by other conservation commitments of the 1997 HCP, *Policy for Sustainable Forests*, or other DNR policies or regulations is reported here.

Habitat quality in LTFC

As with the other alternatives, habitat quality increases through the life of the HCP under Alternative B. The largest increases are in a shift of acres from the non-habitat category into lower-quality habitat. The following figures show the change in LTFC habitat quality as a percentage of LTFC.

Figure 2.3.6. Starting and Ending Habitat Quality—Alternative B

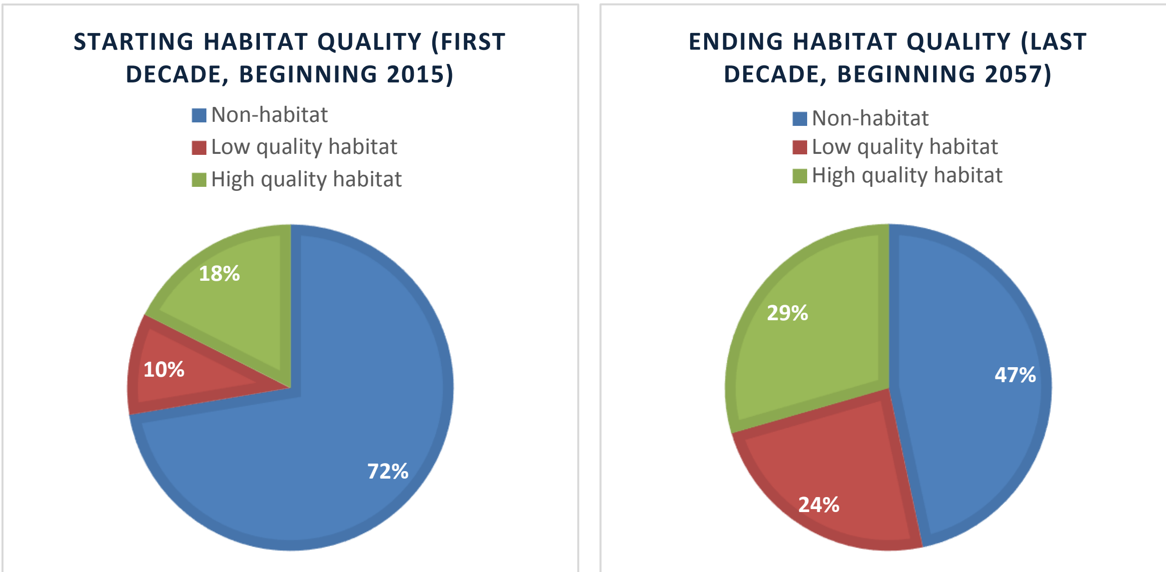
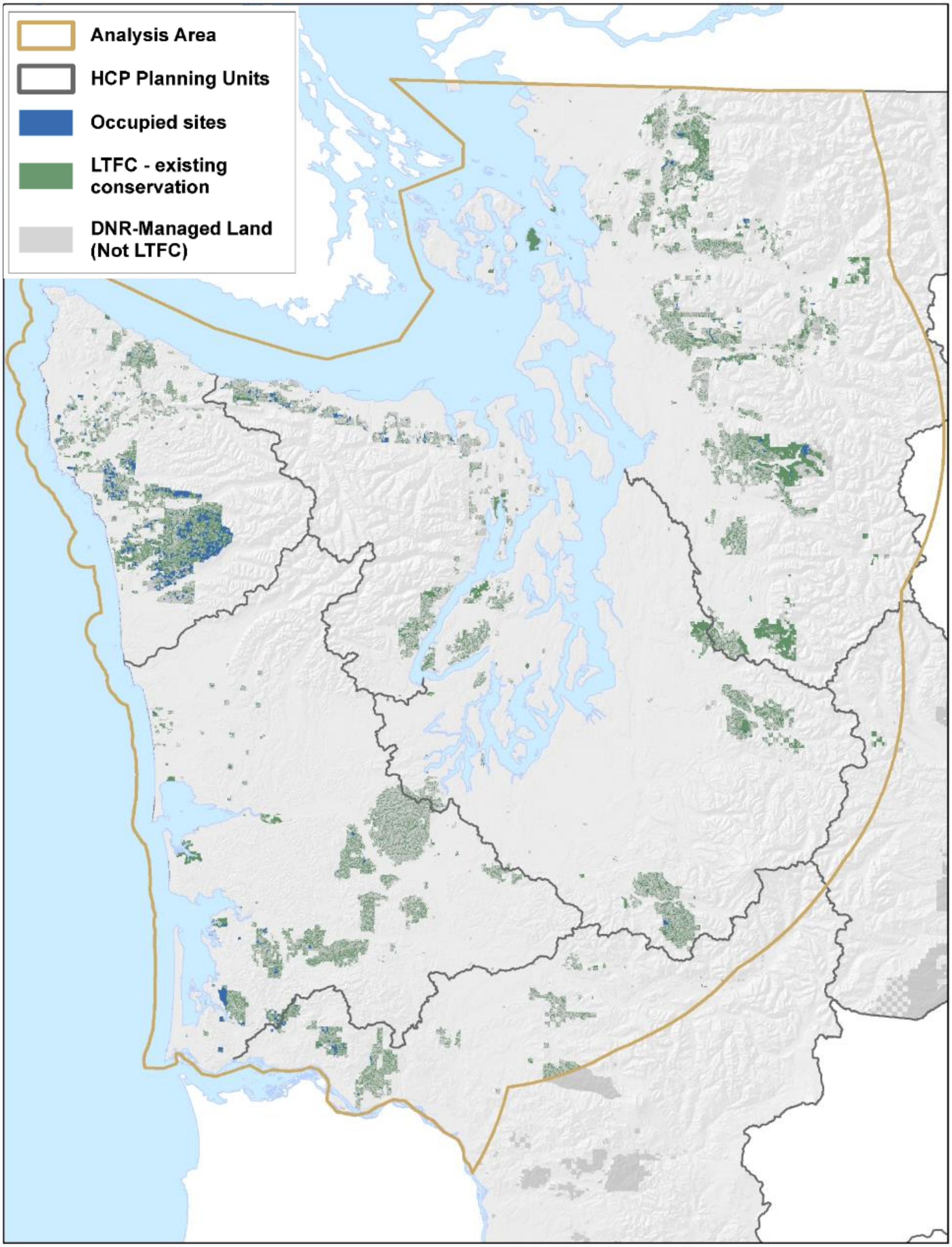


Figure 2.3.7. Habitat Location—Alternative B



Alternative C

Alternative C includes approximately **636,000** acres of LTFC. This alternative contains both marbled murrelet emphasis areas and special habitat areas as well as other high-quality habitat patches (with a P-stage value of 0.47 or greater). This alternative also applies a 100-meter buffer to all occupied sites except in the OESF planning unit, where this buffer is 50 meters for occupied sites greater than 200 acres. Within each of the nine emphasis areas:

- Lands within 0.5 mile of occupied sites are conserved to provide security forest conditions that function to reduce the effects of habitat fragmentation.
- All current habitat (P-stage value 0.25 or greater) is conserved.
- All future habitat (all lands that will reach a P-stage value by the final decade of the HCP) is conserved.
- Thinning is allowed in occupied site buffers (outside of special habitat areas) to develop security forest or enhance nesting habitat
- Thinning is allowed in areas expected to develop into future habitat.
- Active management (including variable retention harvest) is allowed on lands hat are not designated as future habitat or LTFC.

Table 2.3.3. Marbled Murrelet-Specific Conservation Acres—Alternative C

Type of conservation area	Acres (estimated)
Occupied sites	10,000
Occupied site buffers	13,000
Emphasis areas	14,000
Special habitat areas	9,000
0.47 P-stage habitat	7,000
Total	53,000

Special habitat areas are smaller than emphasis areas and are designed to increase murrelet productivity by reducing edge and fragmentation around more isolated occupied sites that are not within an emphasis area. Within the 20 special habitat areas under Alternative C, no harvest or thinning activities are allowed.

Habitat quality in LTFC

The portion of habitat in each quality category is shown as a percentage of total long-term forest cover.

Figure 2.3.8. Starting and Ending Habitat Quality—Alternative C

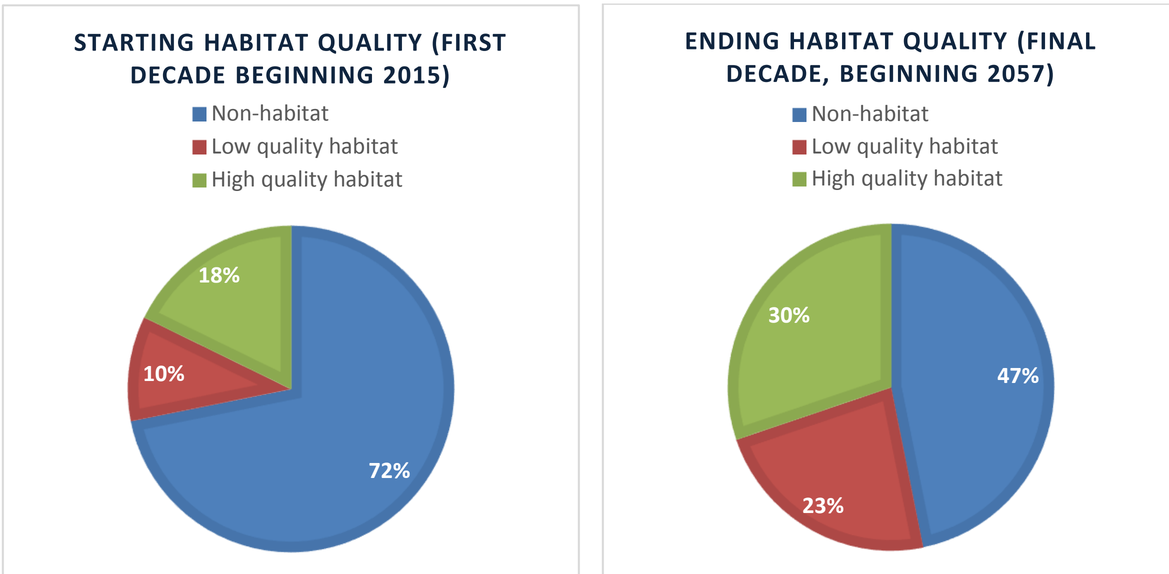
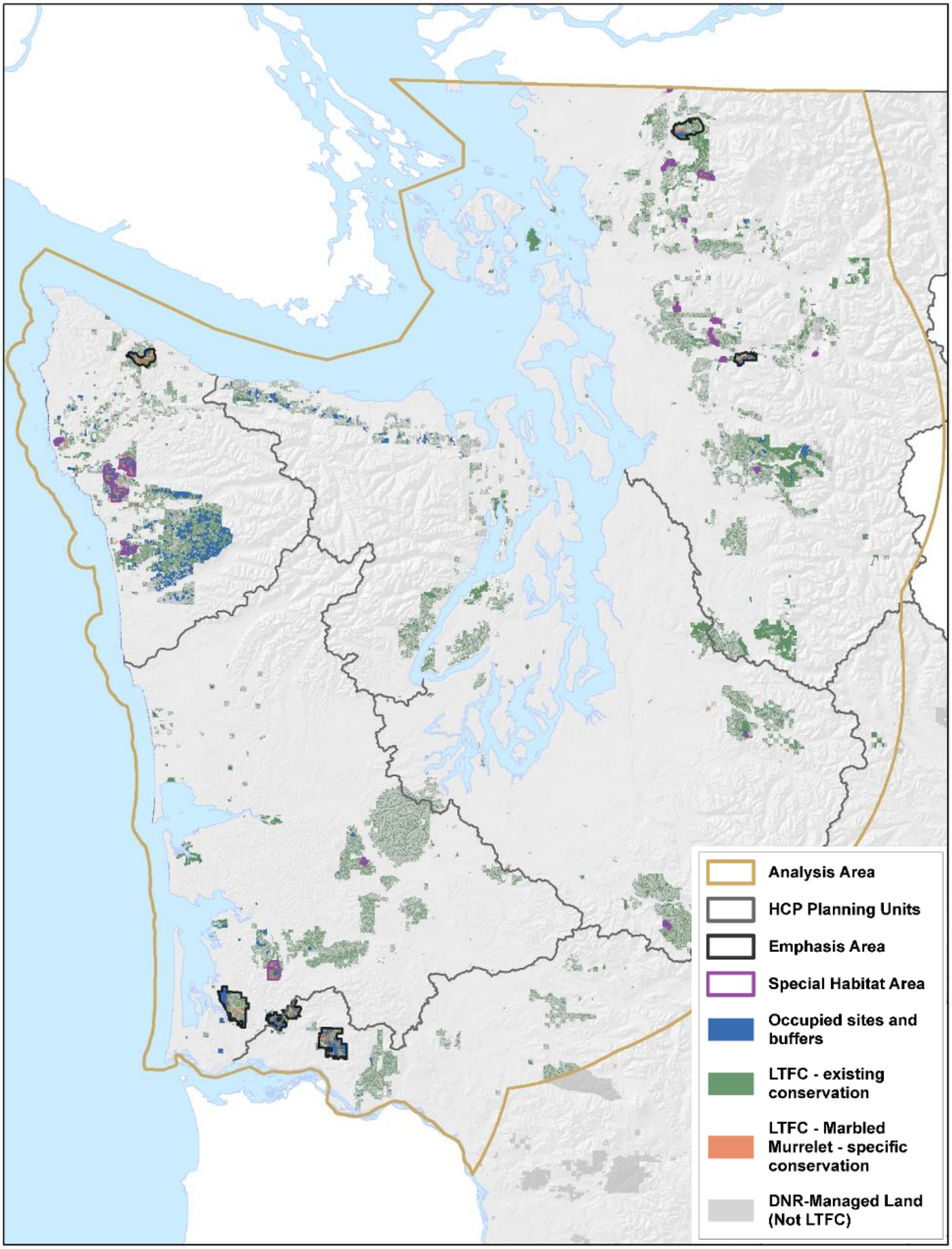


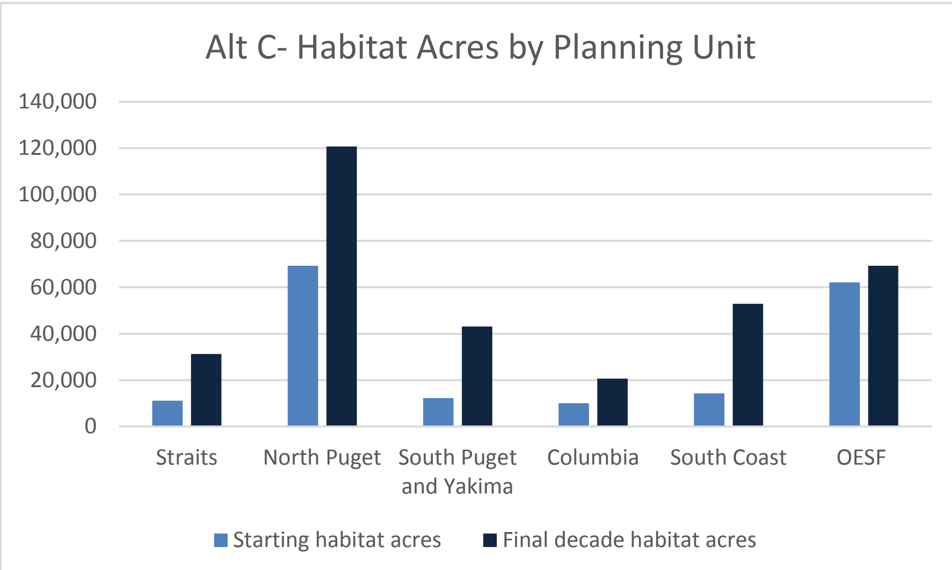
Figure 2.3.9. Habitat Location—Alternative C



Habitat composition and distribution

Figure 2.3.10 depicts the growth of habitat (acres of land with a P-stage value) within LTFC at the beginning of the planning period (2015) compared with the final decade of the planning period (beginning 2057). The figure also illustrates the distribution of habitat acres among the planning units.

Figure 2.3.10. Habitat Growth by Planning Unit—Alternative C



Alternative D

Alternative D concentrates marbled murrelet conservation into 34 special habitat areas. LTFC totals approximately **634,000 acres**. The boundaries of the special habitat areas were identified based on existing landscape conditions (management history, watershed boundaries, and natural breaks or openings). These special habitat areas are designed to increase the productivity of existing occupied sites by reducing edge and fragmentation effects. They are generally smaller but more numerous than emphasis areas and reduce fragmentation and edge effects by prohibiting variable retention harvest and thinning treatments. They include:

- Strategically located occupied sites with 100-meter buffers, except in OESF where sites greater than or equal to 200 acres have 50-meter buffers.
- Adjacent P-stage habitat (both existing and expected to develop through 2067).
- Adjacent non-habitat areas intended to provide security to existing and future habitat (security forests).

Alternative D focuses on reducing fragmentation around occupied sites and would allow more acres of potential habitat (habitat that has or will develop a P-stage value) to be harvested outside LTFC than Alternative C.

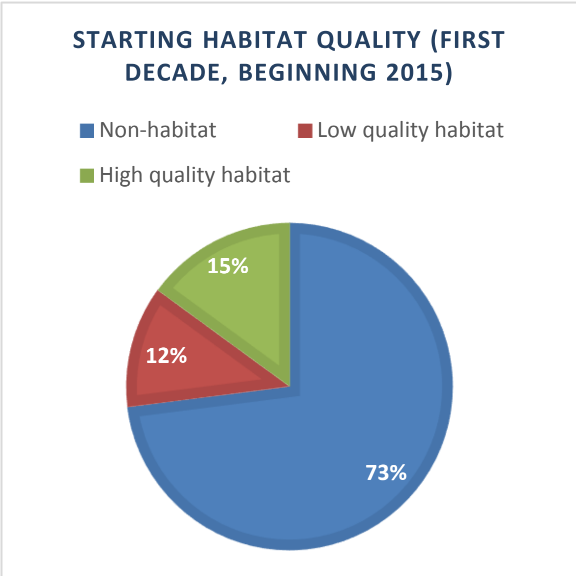
Table 2.3.4. Marbled Murrelet-Specific Conservation Acres—Alternative D

Type of conservation area	Acres (estimated)
Occupied sites	10,000
Occupied site buffers	13,000
Special habitat areas	28,000
Total	**51,000**

Habitat quality in LTFC

Habitat quality is expressed in the following figures as a percentage of total LTFC in each habitat category.

Figure 2.3.11. Starting and Ending Habitat Quality—Alternative D



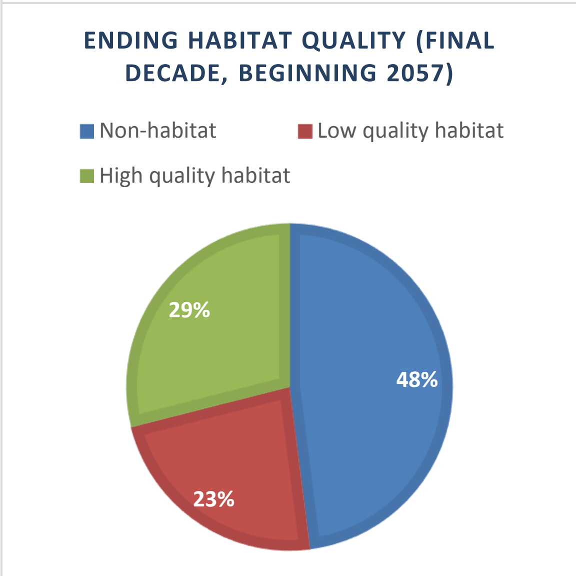
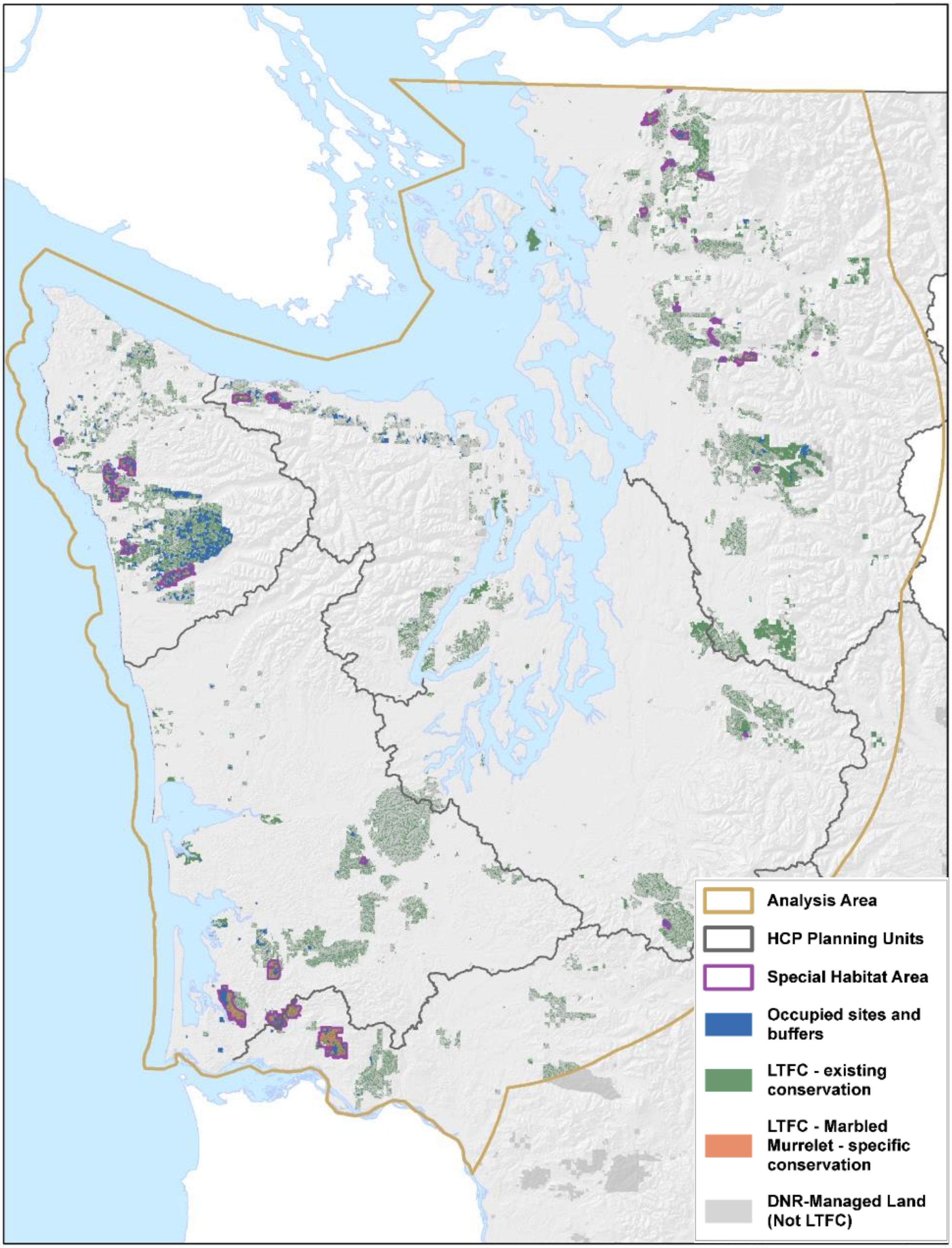


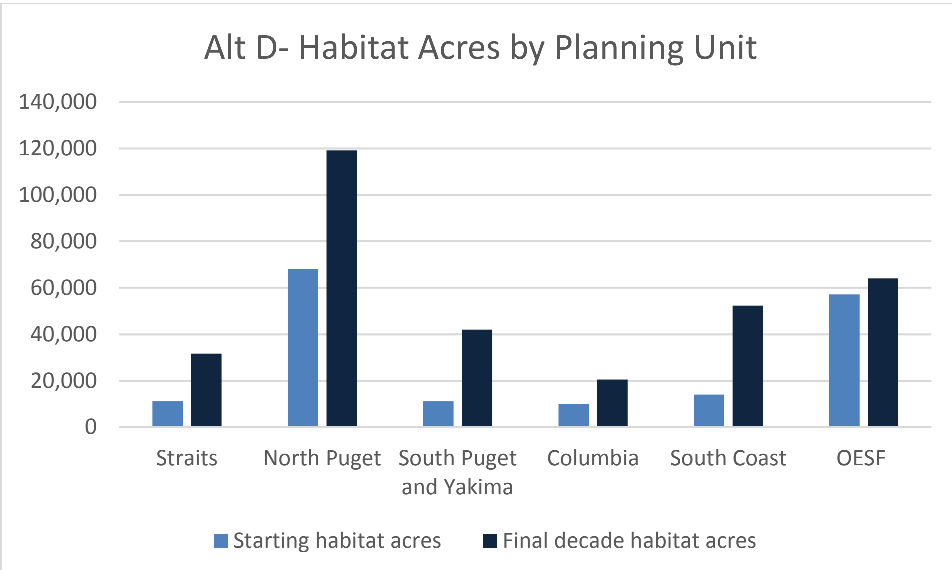
Figure 2.3.12. Habitat Location—Alternative D



Habitat composition and distribution

Figure 2.3.12 depicts the growth of habitat (acres of land with a P-stage value) within LTFC at the beginning of the planning period (2015) compared with the final decade of the planning period (beginning 2057). The figure also illustrates the distribution of habitat acres among the planning units.

Figure 2.3.13. Habitat Growth by Planning Unit—Alternative D



Alternative E

Alternative E combines the conservation approaches of Alternatives C and D (including conservation measures) for a total of approximately **640,000 acres** of long-term forest cover. This alternative includes the following murrelet-specific conservation lands:

- Occupied sites with 100-meter buffers, except in OESF where sites greater than or equal to 200 acres have 50-meter buffers.
- All habitat with a P-stage value of 0.47 and greater throughout the analysis area.
- Emphasis areas as designated under Alternative C.
- Special habitat areas as designated under Alternative D. (Where emphasis areas and special habitat areas overlap, an emphasis area will be the designation.)

Table 2.3.5 provides a summary of the acres in each type of murrelet conservation area.

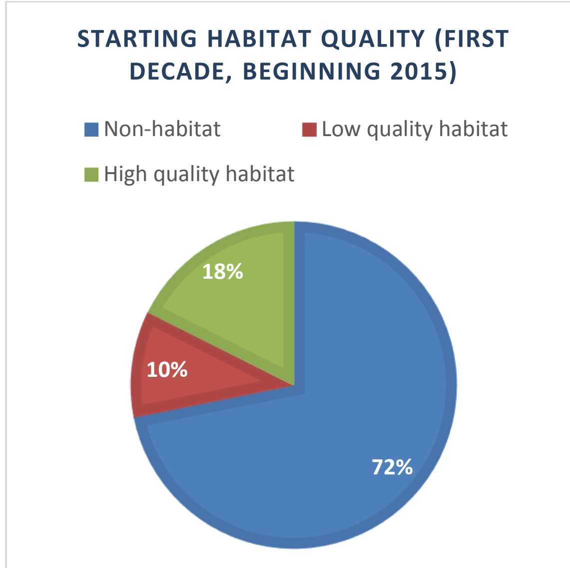
Table 2.3.5. Marbled Murrelet-Specific Conservation Acres—Alternative E

Type of conservation area	Acres (estimated)
Occupied sites	10,000
Occupied site buffers	13,000
Emphasis areas	14,000
Special habitat areas	13,000
0.47 P-stage	7,000
Total	**57,000**

Habitat quality in LTFC

Habitat quality is expressed in the following figures as a percentage of total LTFC in each habitat category.

Figure 2.3.14. Starting and Ending Habitat Quality—Alternative E



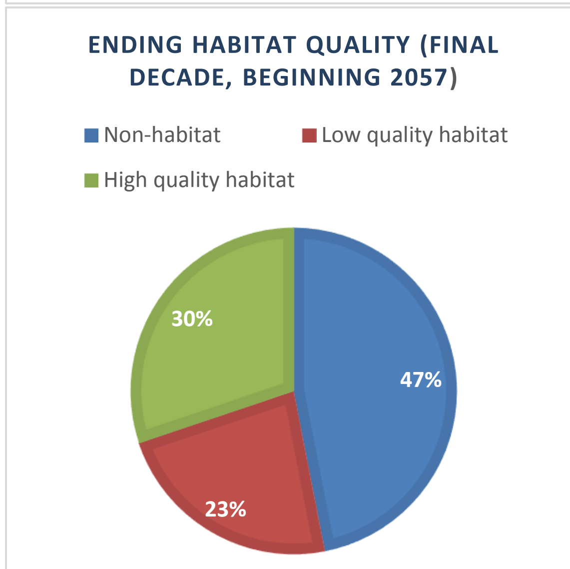
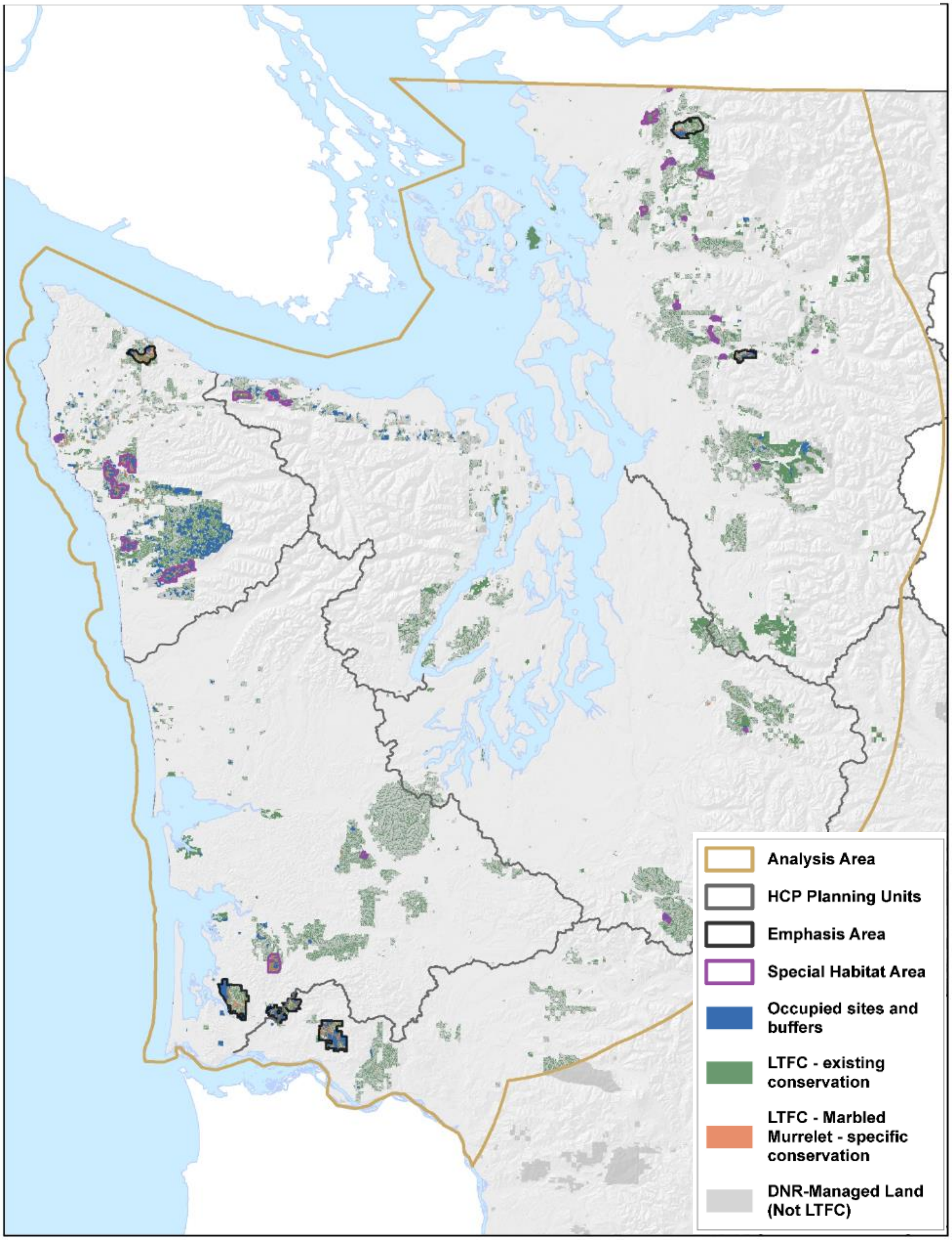


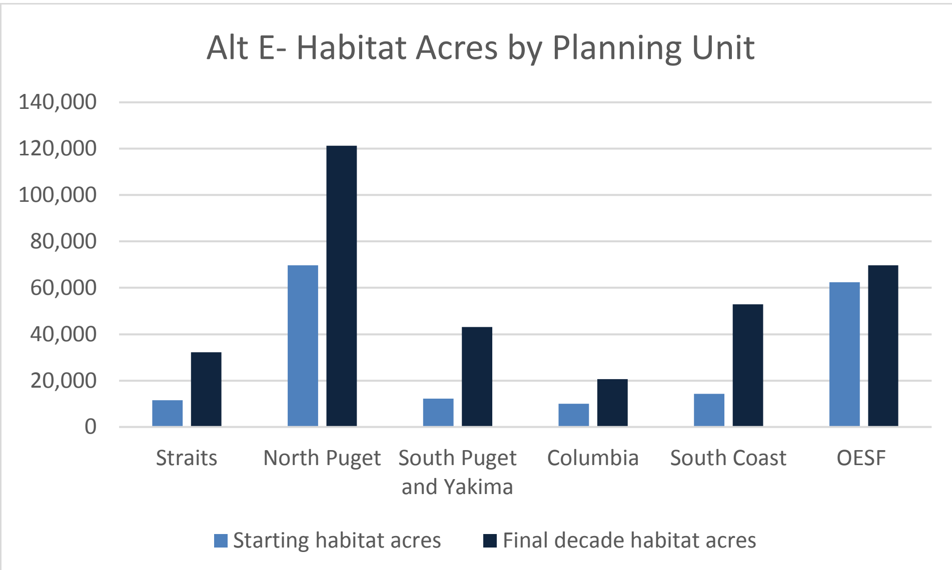
Figure 2.3.15. Habitat Location—Alternative E



Habitat composition and distribution

Figure 2.3.16 depicts the growth of habitat (acres of land with a P-stage value) within LTFC at the beginning of the planning period (2015) compared with the final decade of the planning period (beginning 2057). The figure also illustrates the distribution of habitat acres among the planning units.

Figure 2.3.16. Habitat Growth by Planning Unit—Alternative E



Alternative F

Alternative F proposes to protect approximately **734,000** acres of marbled murrelet habitat by designating the marbled murrelet management areas recommended in the Science Team Report and establishing marbled murrelet management areas in the North and South Puget planning units (which were not part of the Science Team Report). All occupied sites would also be protected, including a 100-meter buffer. Additionally, all old forest habitat (as defined the 1997 HCP) in OESF would receive a 100-meter buffer. Existing mapped low-quality northern spotted owl habitat in designated owl conservation areas (nesting/roosting/foraging, dispersal, and OESF) is included as LTFC. (Alternatives A through E only include high-quality owl habitat as LTFC.)[21] Thinning would not be allowed in occupied sites but would be allowed within buffers to enhance habitat or maintain canopy cover. Elsewhere in MMMAs, thinning would be allowed in future P-stage habitat to enhance habitat development.

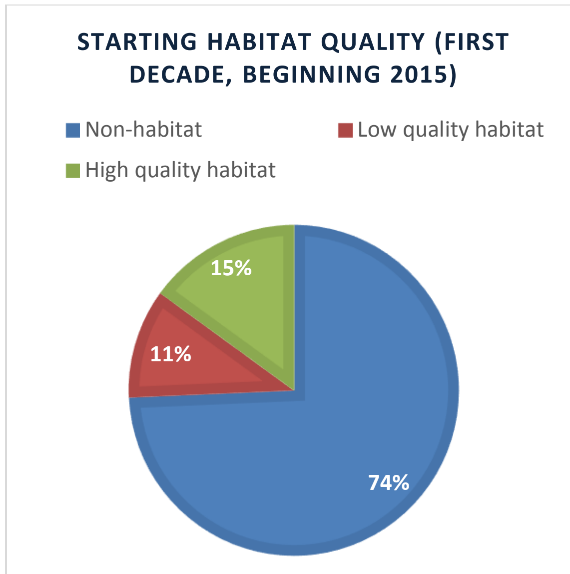
Table 2.3.6. Alternative F - Marbled Murrelet-Specific Conservation Acres—Alternative F

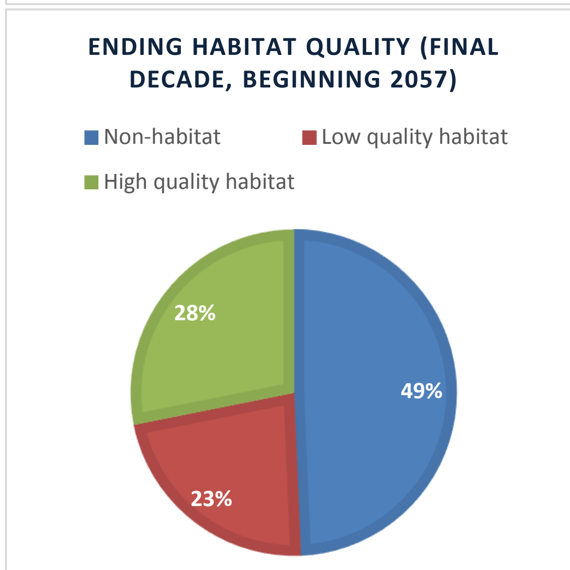
Type of conservation area	Acres (estimated)
Occupied sites	10,000
Occupied site buffers	16,000
MMMAs	78,000
Spotted owl low-quality habitat	47,000
Total	**151,000**

Habitat quality in LTFC

The quality of habitat under Alternative F at the beginning of the conservation strategy and in the final decade of the strategy is depicted in the following figures. The percentage of high-quality habitat in the first decade is lower than most of the other alternatives. This is largely due to the inclusion of low-quality spotted owl habitat in Alternative F.

Figure 2.3.17. Starting and Ending Habitat Quality—Alternative F





[21] Note that "settlement" northern spotted owl habitat would not be included as LTFC.

Habitat composition and distribution

Figure 2.3.18 shows starting habitat acres (acres with a P-stage) value in 2015. Final decade habitat acres include all LTFC acres with a P-stage value by the final decade of the planning period, beginning in 2057.

Figure 2.3.18. Habitat Growth by Planning Unit—Alternative F

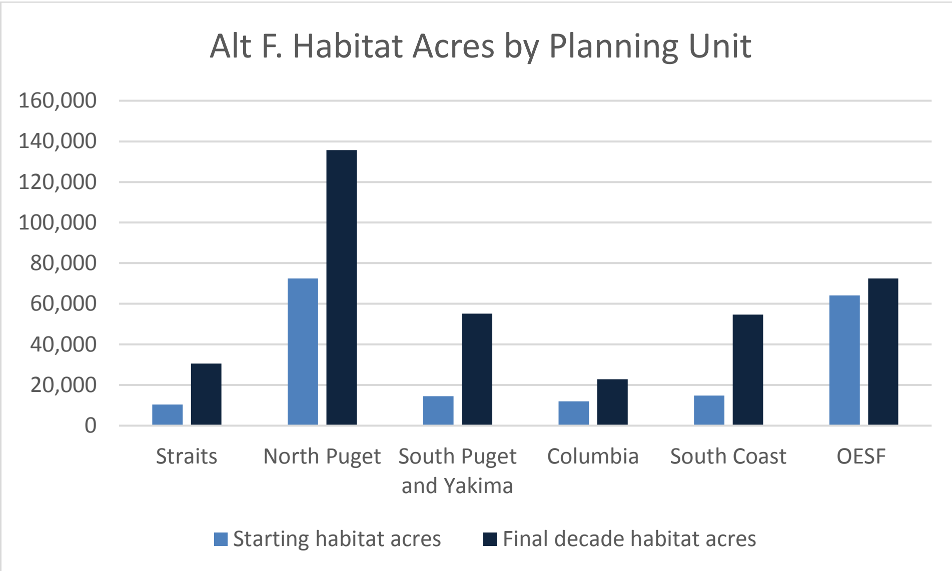
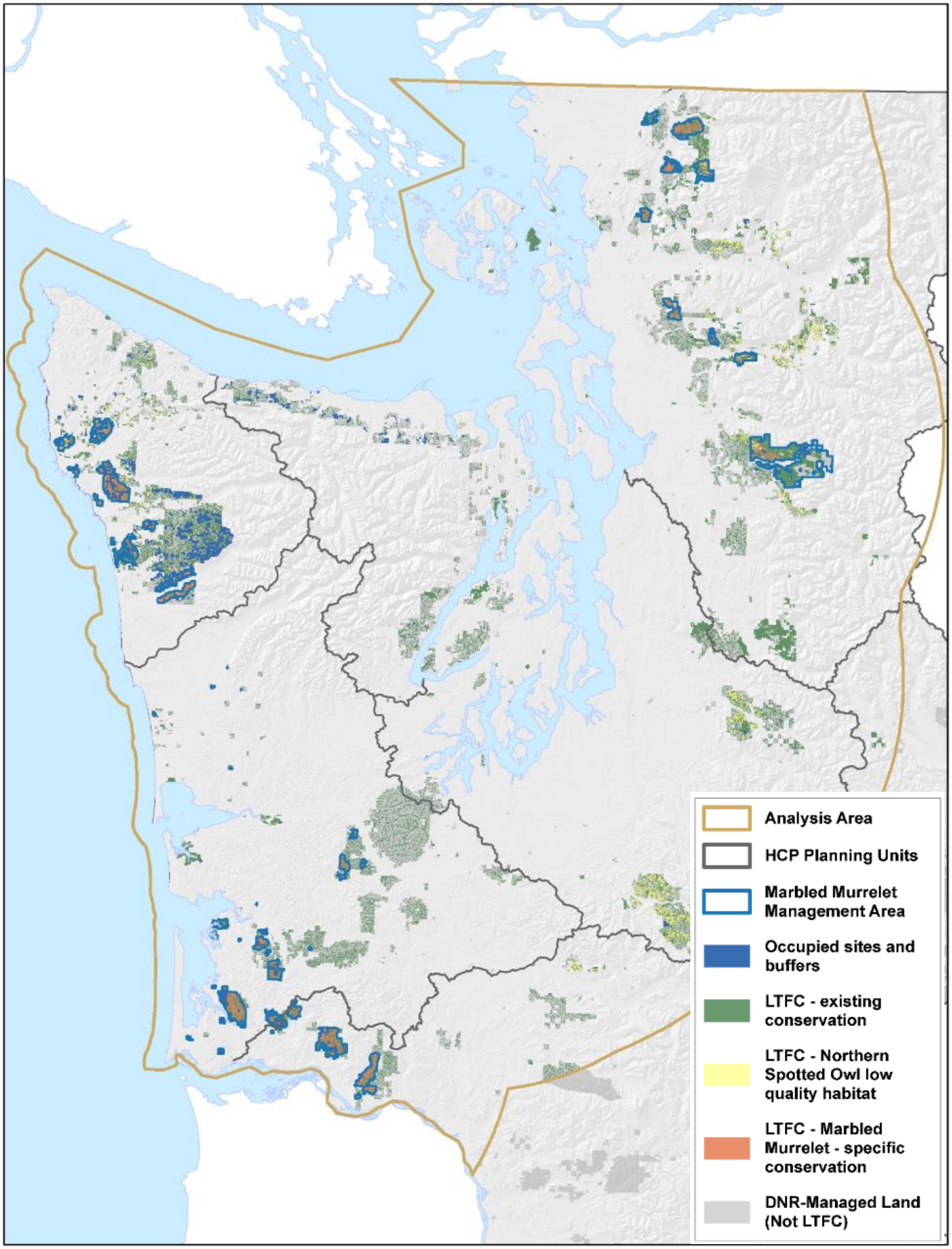


Figure 2.3.19. Habitat Location—Alternative F



2.4 Comparing the Alternatives

This section provides a summary of how LTFC is composed under each alternative, including acres conserved and acres available for harvest.

■ Comparing major components of the alternatives

Table 2.4.1 Comparing the Proposed Alternatives

<table>
<tr><th colspan="2">Contributing components of the marbled murrelet habitat conservation strategy</th><th>Alternative A</th><th>Alternative B</th><th>Alternative C</th><th>Alternative D</th><th>Alternative E</th><th>Alternative F</th></tr>
<tr><td colspan="2">Approximate acres of long-term forest cover</td><td>620,000</td><td>593,000</td><td>636,000</td><td>634,000</td><td>640,000</td><td>734,000</td></tr>
<tr><td rowspan="5">Existing habitat conservation that provides marbled murrelet conservation benefits</td><td>Natural areas[a]</td><td>✓[b]</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Riparian management zones[c]</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Conservation commitments made in the Policy for Sustainable Forests</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Existing northern spotted owl habitat—high-quality[d]</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Existing northern spotted owl habitat—low-quality[e]</td><td></td><td></td><td></td><td></td><td></td><td>✓</td></tr>
<tr><td rowspan="5">Marbled murrelet habitat conservation areas</td><td>Occupied sites—HCP surveyed[f]</td><td>✓</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Occupied sites—Science Team mapped[g]</td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Buffers on occupied sites</td><td>100 meters</td><td>0</td><td colspan="3">100 meters on all, except in OESF where sites greater than or equal to 200 acres have 50 meters</td><td>100 meters</td></tr>
<tr><td>Habitat types identified under interim strategy[h]</td><td>✓</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Marbled murrelet management areas</td><td></td><td></td><td></td><td></td><td></td><td>✓</td></tr>
</table>

Contributing components of the marbled murrelet habitat conservation strategy			Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
		High-quality murrelet habitat (P-stage ≥ 0.47)			✓		✓	
		Emphasis areas[i]			✓		✓	
		Special habitat areas[j]			✓	✓	✓	
Forest management <u>within</u> LTFC		Harvests that create large openings, such as clear cuts and variable retention harvests.		No planned harvests allowed.				
		Limited management (includes silvicultural treatments such as thinnings, salvage reforestation)		Treatments are generally allowed in operable, non-marbled murrelet habitat (outside of special habitat areas) consistent with other land management objectives.				
		Marbled murrelet habitat enhancement treatments	✓	✓	Habitat enhancement treatments are allowed in non-habitat within emphasis areas, with the objective of developing habitat within the life of the HCP.			✓
		Non-timber harvest land uses	Per 1997 HCP and concurrence letters	Management of existing land uses and related infrastructure will continue per existing law and policy, with ongoing disturbance impacts to LTFC identified and mitigated. New or expanded non-timber land uses are subject to conservation measures (described in Section 2.2).				
Forest management <u>outside</u> LTFC		Harvest, thinning, silviculture, and non-timber land uses	Forest stands managed consistent with the Sustainable Harvest Calculation, *Riparian Forest Restoration Strategy*, HCP, *Policy for Sustainable Forests*, Forest Practices rules, forest land plans, and the Multiple Use Act.					

a. Natural areas include Natural Areas Preserves (NAP) and Natural Resource Conservation Areas (NRCA).

b. The "✓" symbol represents the land included in the long-term forest cover definition for the alternative. Notes are added to clarify the inclusion or exclusion of an area.

c. Riparian management zones per the 1997 HCP Riparian Forest Restoration Strategy for the five west-side HCP planning units and per the OESF HCP riparian conservation strategy.

d. Existing northern spotted owl high-quality habitat refers to the following DNR mapped habitat classes as of 2015: old forest, high-quality nesting habitat, and A and B habitat per the definitions in the 1997 HCP (DNR 1997, p. 12).

e. Existing northern spotted owl low-quality habitat refers to the following DNR-mapped habitat classes as of 2015: sub-mature, movement roosting and foraging, movement, young forest marginal and dispersal habitat per the definitions in the 1997 HCP (DNR 1997, p. 12) and the 2008 *South Puget Forest Land Plan*.
f. Occupied sites as defined by DNR survey boundaries where murrelet breeding behaviors are observed or there is evidence of nesting consistent with the *Pacific Seabird Group Survey Protocol*.
g. Occupied sites as mapped by the Science Team (Raphael and others 2008).
h. Refers to "reclassified habitat" in step 4 of the interim strategy (DNR 1997, p. 40) and various marbled murrelet habitat types defined in the 2007 concurrence letters for North and South Puget HCP planning units. LTFC for Alternative A includes all reclassified habitat in the OESF and Straits HCP planning units, as well as all reclassified habitat with a current P-stage value in southwest Washington.
i. Emphasis areas represent larger blocks of habitat and non-habitat areas that will be managed for both marbled murrelet conservation and harvest.
j. Special habitat areas augment acres of LTFC around certain occupied sites and create blocks of cohesive habitat with reduced fragmentation.

■ How much land is available for harvest?

Under each alternative, a full range of management options (harvest, thinning, and related silviculture) is expected to be available on DNR-managed forestland *outside* LTFC.

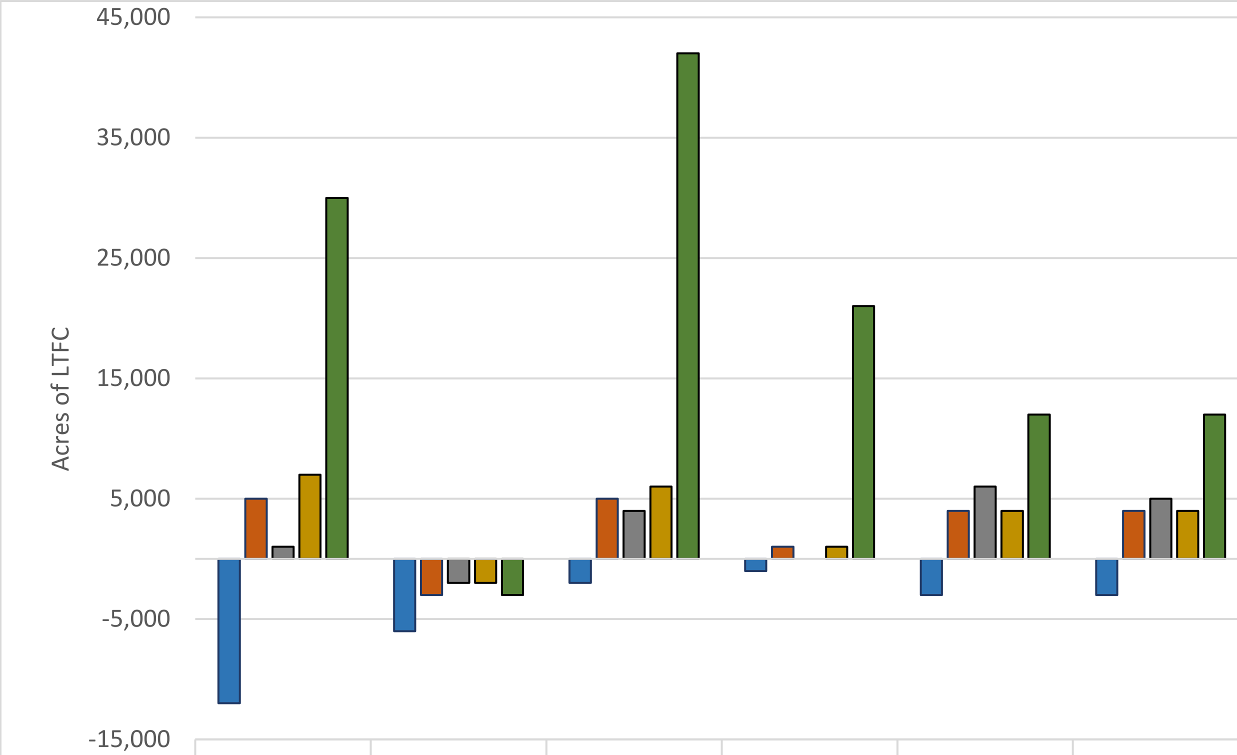
Within LTFC, harvest is generally prohibited, and thinning is limited as described in the conservation measures in the previous section. Sections 3.11 and 4.11, Socioeconomics, analyze in detail what lands may be available for harvest in the analysis area under each alternative. Figure 2.4.1 shows the estimated change in total acres of LTFC under each alternative by planning unit compared with the no action alternative. (Acres are from the final decade of the planning period.)

Text Box 2.4.1

Under the action alternatives, could DNR harvest in some areas that are currently protected?

Yes. Some land currently deferred from harvest under the no action alternative may become available for harvest under one or more of the action alternatives. This is due to a shifting emphasis in conservation to areas with potentially higher habitat value to the murrelet.

Figure 2.4.1. Estimated Change in LTFC Acres from Alternative A (No Action), by HCP Planning Unit



	OESF	Straits	North Puget	South Puget and Yakima	Columbia	South Coast
Alternative B	-12,000	-6000	-2000	-1000	-3000	-3000
Alternative C	5000	-3000	5000	1000	4000	4000
Alternative D	1000	-2000	4000	0	6000	5000
Alternative E	7000	-2000	6000	1000	4000	4000
Alternative F	30,000	-3000	42,000	21,000	12,000	12,000

Compared with the no action alternative, Alternative B would increase the land available for active forest management by approximately 27,000 acres. Alternatives C through E reduce the land available for harvest by approximately 14,000 to 20,000 acres, and Alternative F reduces available land by approximately 114,000 acres. Appendix F contains maps for each planning unit showing where these changes occur on the landscape.

It is important to understand that some acres currently deferred from harvest under the no action alternative (generally, reclassified murrelet habitat) may become available for harvest under one or more of the action alternatives. This is because the action alternatives change the emphasis of conservation, focusing in some cases on areas with higher-quality habitat than are identified under Alternative A or, in the case of Alternative B, focusing only on occupied sites and not broader habitat conservation areas.

■ How does habitat compare across the alternatives?

In Chapter 4, differences in habitat quality and configuration among the alternatives are explored in detail as they relate to the marbled murrelet. This section provides a more general comparison of habitat quality among the alternatives.

Text Box 2.4.2

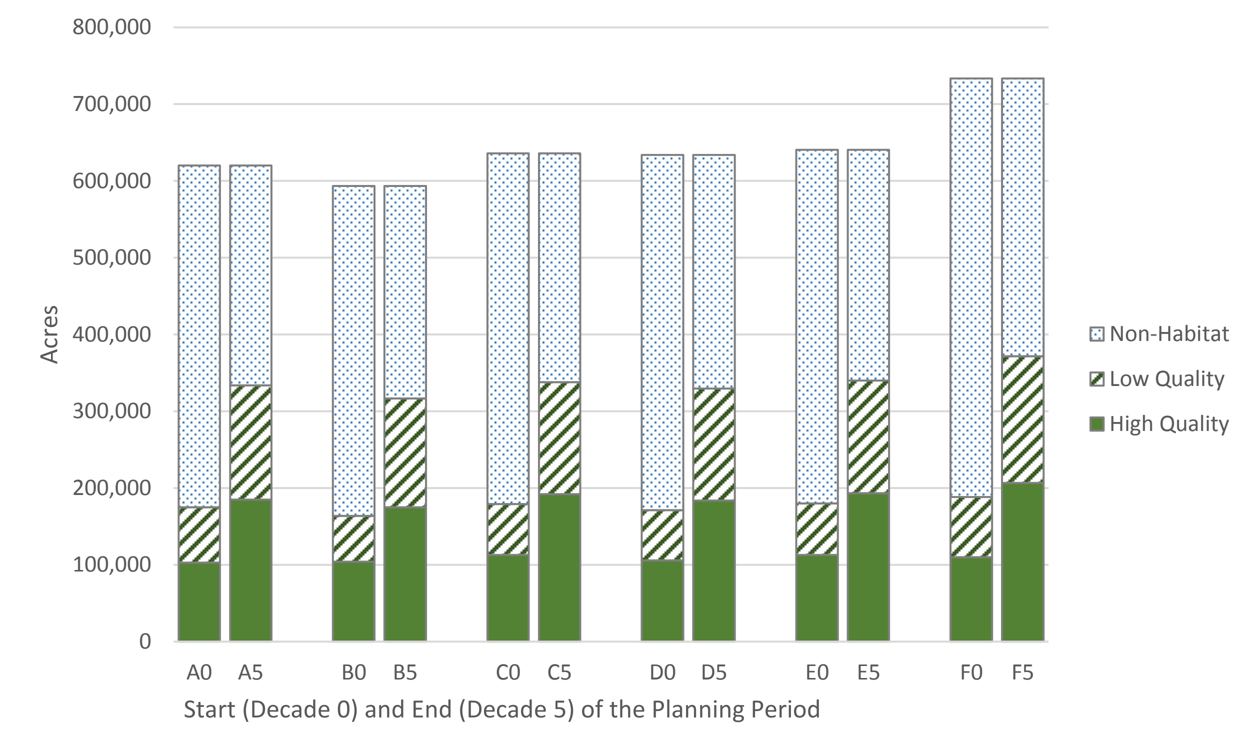
Does more habitat develop through time?

Yes. Under all of the alternatives, the acres of marbled murrelet habitat are greater in the final decade of the HCP than at the beginning of the long-term conservation strategy.

Habitat composition and quality

As illustrated in the previous sections, long-term forest cover contains both habitat (forestlands with a P-stage value) and non-habitat (forestlands with no P-stage value, but that contribute to conservation as security forest or buffers). As forests mature and develop into habitat through time, how much habitat is “captured” by LTFC increases, and the quality of that habitat changes. Figure 2.4.2 compares the habitat quality (high or low) versus non-habitat (non) composition of LTFC among alternatives between the start of the planning period (2015) and the end decade of the planning period (2057–2067).

Figure 2.4.2. Increases in Habitat Quality of LTFC Over Time, by Alternative



Under all of the alternatives, habitat grows significantly over time by the end of the planning period. Habitat exceeds non-habitat as a proportion of LTFC in every alternative by the end of the planning period. Alternative F is closer to a 50:50 split of habitat to non-habitat, while Alternatives A through E are closer to a 53:47 habitat to non-habitat ratio.

Habitat quality also increases over time under every alternative. Most of the growth of new habitat occurs as low-quality habitat develops out of existing forest stands that begin the planning period with a P-stage value of zero (0). This is reflected in the pie charts shown under the alternative profiles and is summarized in Table 2.4.2. On average, all alternatives show between 23 and 26 percent conversion of non-habitat to habitat through the planning period.

Habitat configuration

The configuration of habitat conserved in LTFC also varies among alternatives. A measure of configuration is the size of interior forest patches relative to edge habitat. For purposes of this DEIS, we categorize LTFC into one of the following configurations:

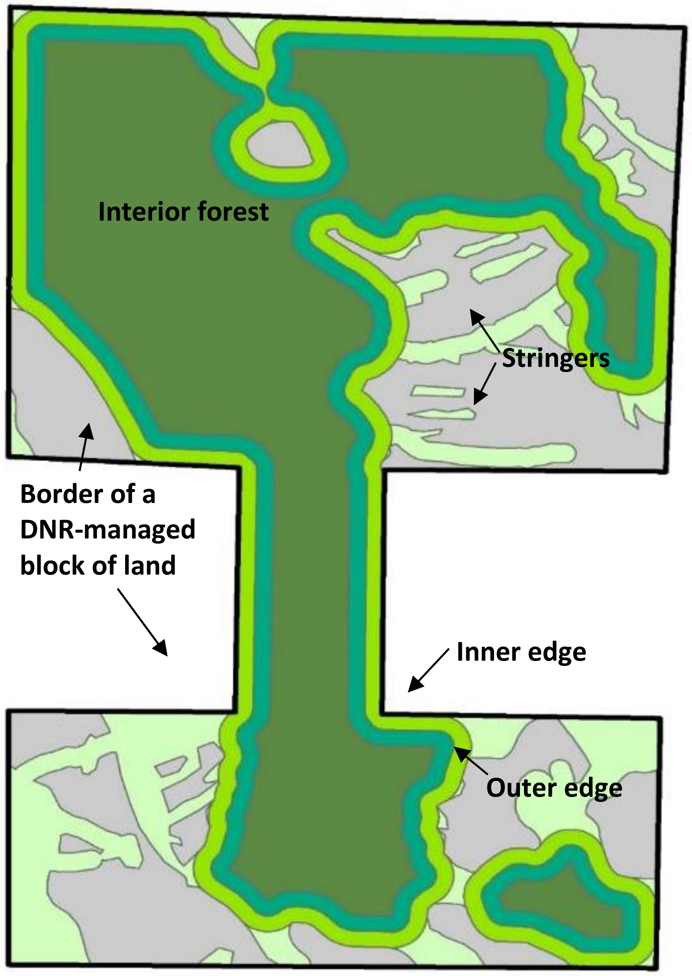
- ***Interior forest:*** The interior forest is comprised of forested area (patch) that is at least 100 meters from any type of edge. These interior areas are protected from effects associated with harvest edges.
- ***Inner edge:*** The inner edge is a forested area 51 to 100 meters from the edge of the actively managed forest and is adjacent to the interior forest patch.
- ***Outer edge:*** The outer edge of the interior forest patch is located between 0 to 50 meters from the edge of the managed forest. The literature indicates that the edge effects from the actively managed forest extend further than 50 meters into the stand but diminish until there is minimal effect after 100 meters from the managed area (Burger and others 2004).
- ***Stringer:*** This term refers to long, relatively narrow (less than 200 meters wide) corridors of LTFC, primarily associated with riparian areas. These areas can still provide security forest for the marbled murrelet and are not subject to take. However, because they lack interior forest, they are unlikely to be used for successful nesting and are therefore not assigned mitigation value for purposes of calculating the balance between potential take and mitigation under each alternative (refer to the following section and Appendix H).

Text Box 2.4.3

What is "edge," and how does it affect the murrelet?

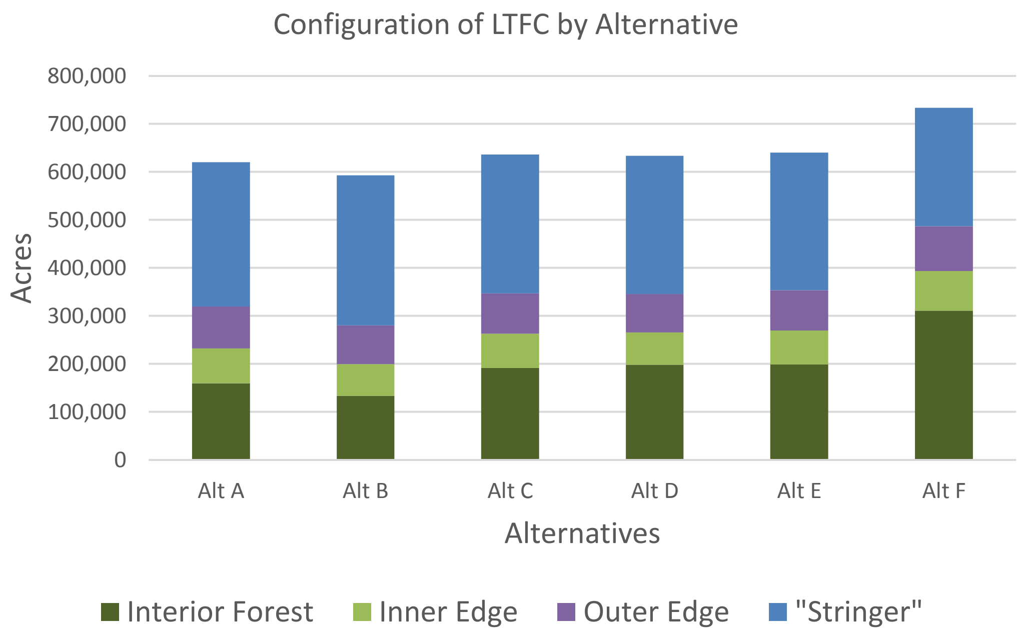
An edge is a transition or boundary between two habitat types. Forest edges are created by roads, harvests, changes in species composition, and physical changes in the landscape. Studies (e.g., Burger and others 2004, Malt and Lank 2009) have shown that predation risk at marbled murrelet nests is likely higher near forest edges and fragmented landscapes. Refer to Chapter 4 and Appendix H for more information about edges and their potential impacts.

Figure 2.4.3. Illustration of Long-Term Forest Cover (LTFC) and Categories of Edge on a Block of DNR-Managed Land



The configuration of LTFC under different alternatives is used in the analysis of potential environmental consequences (Chapter 4) for elements of the environment sensitive to habitat configuration. Comparisons can be made of species diversity found in interior forests compared to edge environments. The type and amount of edge are also major factors in assigning mitigation values to the different alternatives (refer to Chapter 4 and Appendix H for a more detailed explanation of the mitigation "discounts" given for edges and stringers).

Figure 2.4.4. Comparison of Interior, Edge, and Stringer Acres, by Alternative



As illustrated in Figure 2.4.4, long-term forest cover under each alternative has different amounts of interior forest and different proportions of interior forest to edge or stringer forest.

■ Summary of potential impacts to the environment

Chapter 4 includes an analysis of the alternatives for potential impacts to twelve different elements of the environment. A summary is provided in this section. Specific impacts are described in detail in Chapter 4, and Chapter 5 describes potential cumulative effects beyond those described for each element of the environment.

Natural environment: Earth, climate, aquatic resources, vegetation, wildlife, and marbled murrelets

Forests within long-term forest cover are expected to become more structurally complex through time and experience less active management. Elements of the natural environment are not expected to be adversely impacted by these changes. Soil resources and areas subject to landslide hazards would continue to be protected by existing DNR regulations, policies, and procedures. The alternatives are not expected to exacerbate climate change impacts on any element of the environment, and carbon sequestration is expected to be greater than emissions under all alternatives.

Existing riparian protection strategies remain in place under all the alternatives and aquatic functions are expected to be maintained or enhanced under all alternatives. Minor localized impacts to microclimate are possible under Alternative B.

Some limitations on thinning (Alternatives C, D, and E) could delay some riparian or natural areas from meeting their restoration objectives within a shorter time frame. However, overall HCP, OESF, and natural areas management objectives are not impacted.

Many wildlife and plant species would benefit from an increase in structurally complex forest that will occur in long-term forest cover over the planning period. Wildlife diversity is likely to increase over time with all alternatives. Some local changes in habitat conditions may temporarily affect some species, but overall abundance and distribution of species, including listed and sensitive species, would remain stable or increase on DNR-managed lands.

In areas where land would be “released” from its current conservation status (including 27,000 acres under Alternative B and between 2,000 and 3,000 acres in the Straits HCP planning unit under Alternatives C through F), the existing framework of regulations, policies, and procedures designed to minimize the environmental impacts from active management would remain in place.

IMPACTS TO MARBLED MURRELET HABITAT AND POPULATIONS

The marbled murrelet population has declined at an average annual rate of 4.4 percent in Washington since monitoring began in 2001. Given this declining trend, it is uncertain whether the murrelet population will respond to increased habitat on federal or state lands in the future under any alternative. However, the distribution and trends in marbled murrelet populations are linked to the amount and configuration of nesting habitat. The alternatives recognize the importance of protecting existing occupied marbled murrelet habitat and recruiting additional habitat in specific areas. The alternatives vary by providing differing levels of habitat protection and recruitment, coupled with some short-term habitat loss. The intent is to improve current population trends through conservation and recruitment of additional nesting habitat on DNR-managed lands.

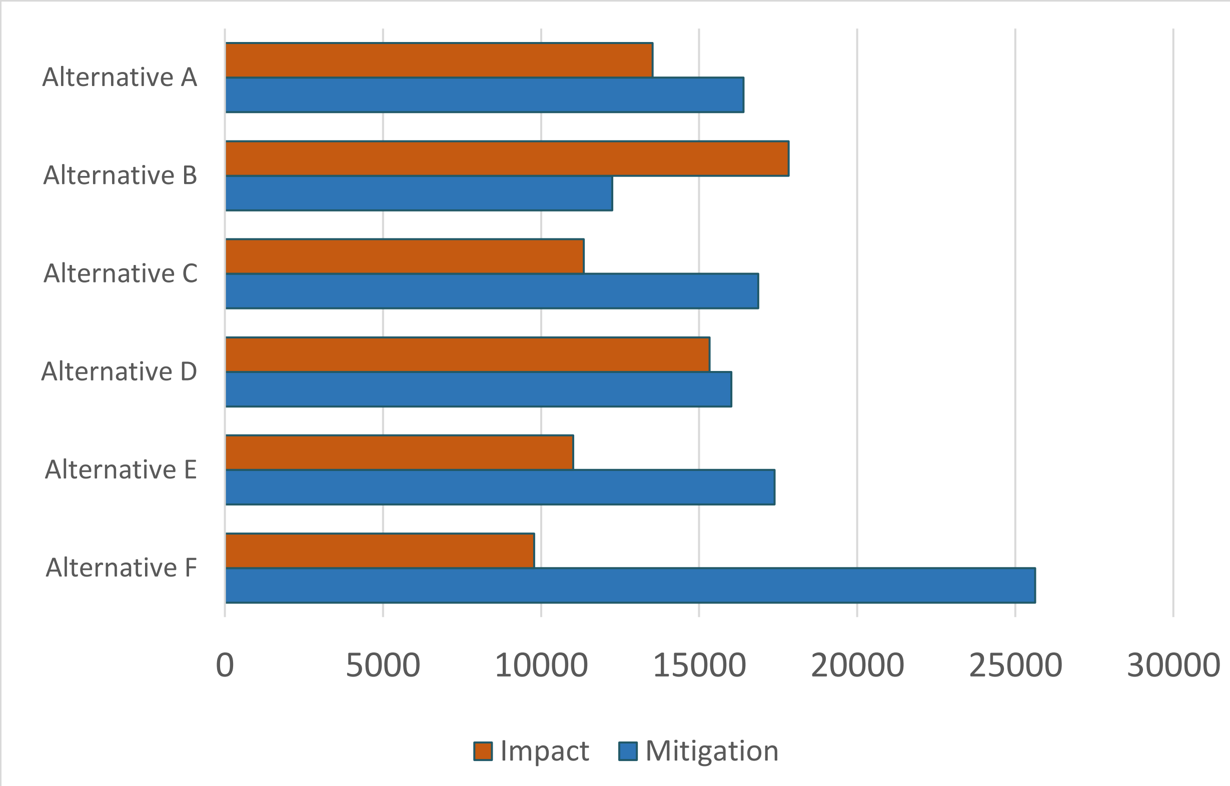
Two analytical approaches were used to estimate alternative-specific impacts to marbled murrelet habitat and populations. The acreage, quality (as influenced by stand condition and edge effects), and timing of habitat harvested and developed under each alternative provide a relatively direct measure of impacts. Potential impacts to the Washington murrelet population were evaluated with a mathematical population viability analysis model based on two different assumptions about the relationship of the murrelet population with forest habitat and other environmental factors: 1) insufficient forest habitat compounds negative effects of other factors, and 2) insufficient forest habitat is the principal negative influence on the murrelet population.

For all alternatives, habitat loss in the short term (the first decade of the planning period, due to harvest of habitat outside of long-term forest cover) is expected to be mitigated over time by the recruitment of more and higher-quality habitat and an increase in interior habitat in strategic locations within long-term forest cover. When the acres of this habitat are adjusted for quality and timing, the cumulative adverse impacts expected to marbled murrelet habitat are exceeded by the mitigation expected under every proposed alternative except Alternative B. Figure 2.4.5 compares impacts to mitigated acres by the end of the 50-year planning period.

Population viability analysis suggests that regardless of alternative, habitat conservation on DNR-managed land can do little at the statewide scale to influence either the risk of local declines or likelihood of population increases if other environmental factors such as marine conditions are limiting. Assuming that nesting habitat is the primary limitation on murrelet population trends allows the analysis to evaluate the influence of habitat on DNR-managed land on local murrelet populations. The statewide population is projected to stabilize under all alternatives, while focusing just on DNR-managed lands suggested local population increases that vary in timing and magnitude were possible under all alternatives.

In summary, the population viability analyses suggest that Alternative B results in the highest risk of local declines and the lowest likelihood of local population increases during the modeled planning period. Alternative F is projected to result in the lowest risk of local declines and the highest likelihood of local population increases, with intermediate results projected under Alternative A and Alternatives C through E.

Figure 2.4.5. Acres of Habitat Loss (Impact) and Gain (Mitigation) by the End of the Planning Period, by Alternative and Adjusted for Quality



Human environment: Recreation, forest roads, public services and utilities, environmental justice, cultural resources, and socioeconomics

Some localized impacts to these elements of the human environment are expected as a result of increasing the acres of marbled murrelet conservation and implementing proposed conservation measures. Cumulatively, these impacts are expected to be minor for all elements of the human environment except socioeconomics (refer to the following section), considering the scale of the analysis area and the availability of other DNR-managed lands for these land uses. Impacts are similar across all action alternatives.

Compared with the no action alternative, adding acres of marbled murrelet conservation would result in local reductions in the land available for new or expanded recreation facilities or non-timber leases/easements, shifting demand to lands elsewhere within the analysis area. Existing facilities, easements, leases, and land uses would remain largely unaffected, although the timing of some maintenance activities could be impacted.

Where conservation measures limit road development, compensatory increases in road miles may occur nearby, but overall road density in the analysis area is unlikely to increase as a result of the alternatives.

Increased road abandonment in conservation areas would likely occur, which in turn could affect recreational use and access within these areas. Continued access to and use of cultural resources is unlikely to be significantly affected, however, and existing DNR policies and procedures for tribal consultation and cultural resource protection remain in place.

No environmental justice impacts under any alternative are anticipated from this conservation strategy, although local economic impacts in two counties could be adverse (as discussed in the next section).

SOCIOECONOMIC IMPACTS

NEPA requires an examination of socioeconomic impacts of the proposed action. Socioeconomic impacts in this analysis concern the relationship of DNR-managed land to local economies, including county revenues, state trust revenues, employment, and local tax generation. These impacts were measured both qualitatively, by considering how activities on DNR-managed land contribute broadly to the local economy, and quantitatively, by attributing assumed values to the acres that would be available for harvest under each alternative.

The change in the value of operable acres was found to be relatively small at the scale of the analysis area. The overall change in operable acres ranges from a 4 percent increase under Alternative B to a decrease of between 1 and 4 percent for Alternatives C through F.

The federally granted trusts would experience minor gains in operable acres under Alternative B (increases between 1 and 6 percent) and minor reductions under Alternatives C through F (decreases between 1 and 6 percent). Exceptions would be the University Grant (original and transferred) trust, which would see a larger reduction (between 11 and 18 percent) under Alternatives C through F, and the Scientific School Grant, which would see a 16 percent reduction under Alternative F. Counties benefiting from State Forest Trust lands would experience either no change or an increase in operable acres under Alternative B (increases up to 20 percent). Several counties would experience small changes in operable acres under Alternatives C through F (from decreases of 5 percent to increases up to 6 percent). Exceptions include Pacific County (decreases from 13 to 23 percent), Wahkiakum County (decreases from 9 to 25 percent) under Alternatives C through F. Under Alternative F, Whatcom and Pierce counties experience reductions of operable acres of 22 percent and 11 percent, respectively.

Alternative B, by increasing the number of operable acres available for harvest as compared with Alternative A, is expected to result in stable or increased harvests levels on all trusts and in all counties in the analysis area, stable or increased revenue or all trust beneficiaries with lands within the analysis area, and stable or increased tax revenue and employment in counties within the analysis area.

Alternatives C through F, by decreasing the number of operable acres available for harvest, are expected to result in stable or decreased harvest levels on most trusts and in all counties in the analysis area, stable or decreased revenue for most trust beneficiaries with lands within the analysis area, and stable or decreased tax revenue and employment in counties within the analysis area.

Pacific and Wahkiakum counties are most likely to be adversely impacted by Alternatives C through F. These counties are more heavily dependent on timber harvest for local government revenue and have below average economic diversity compared with other counties in the analysis area. The economies of Pacific and Wahkiakum counties are therefore less able to tolerate the reduction in harvest volume anticipated under Alternatives C through F because of their low socioeconomic resiliency.

Some of the adverse economic effects due to reduced timber supply in the near term could be offset over time by the cumulative benefits of improved efficiencies and effectiveness in forest management, additional opportunities for thinning (which is more labor intensive), more regulatory certainty under the Endangered Species Act, and potential use of the State Forest Trust Land Replacement Program in Pacific and Wahkiakum counties.

■ How do the alternatives address DNR's project objectives?

The need, purpose, and objectives statement described in Chapter 1 includes five objectives that guided the development of alternatives. This section provides a brief summary of how the alternatives address DNR's project objectives.

1) **Trust Mandate: Generate revenue and other benefits for each trust by meeting DNR's trust responsibilities, including: making trust property productive; preserving the corpus of the trust; exercising reasonable care and skill in managing the trust; acting prudently with respect to trust property; acting with undivided loyalty to trust beneficiaries; and acting impartially with respect to current and future trust beneficiaries.**

   All alternatives allow continued generation of revenue for trust beneficiaries. Revenue streams may be impacted differently depending on the alternative. The alternatives would generate revenue in the following order, from the most revenue to the least revenue: Alternative B, A, D, C, E, F. Revenue estimates are discussed in more detail in Section 4.11, Socioeconomics. Specific impacts to trusts and counties are also discussed in Section 4.11.

2) **Marbled Murrelet Habitat: Provide forest conditions in strategic locations on forested trust lands that minimize and mitigate incidental take of marbled murrelets resulting from DNR forest management activities. In accomplishing this objective, we expect to make a significant contribution to maintaining and protecting marbled murrelet populations.**

   Marbled murrelet-specific conservation areas, in combination with existing HCP conservation strategies, maintain areas in long-term forested condition. These areas are designed to minimize and mitigate incidental take. The proposed conservation measures are designed to avoid and minimize the impacts of certain forest management activities.

   Alternatives C through F modify the current interim approach to murrelet conservation approximated by Alternative A by designating strategically important locations for conservation of marbled murrelet habitat. Alternatives C through F identified strategic locations for marbled murrelet conservation on DNR lands as areas with documented occupied sites and concentrations of murrelet habitat in context of the existing conservation network provided by federal lands. For example, certain DNR lands in southwest Washington were considered strategically important because of their concentrations of documented occupied habitat and because the absence of federal habitat lands in this area could otherwise result in a gap in the otherwise continuous coastal distribution of marbled murrelets in Washington. Likewise, some specific areas in the North Puget, Straits, and OESF landscapes were identified as strategic locations due to presence of important habitat, occupied sites, and proximity to important marine foraging areas. Although Alternative B protects known occupied sites, no additional marbled murrelet-specific conservation areas are identified.

Refer to Section 4.6, Marbled Murrelets, for an evaluation of how these alternatives may affect marbled murrelet populations.

3) **Active Management: Promote active, innovative, and sustainable management on the forested trust land base.**

Each alternative allows continued, sustainable harvest of timber, consistent with existing laws, policies, and the HCP. Harvest of some marbled murrelet habitat is also permitted. Underlying regulations and policies promoting innovation remain in place unless otherwise constrained by specific conservation measures. For example, riparian restoration treatments may be prohibited in special habitat areas but are allowed elsewhere in the analysis area.

The proposed conservation measures also allow innovative thinning treatments that could be used to accelerate the development of marbled murrelet habitat in some areas of LTFC. Impacts to active, innovative, and sustainable management is discussed primarily in Sections 4.6 through 4.9.

4) **Operational Flexibility: Provide flexibility to respond to new information and site specific conditions.**

All alternatives would allow DNR to continue to respond to emergency situations and would not change the existing practice of consultation with USFWS. Site-specific consultation with USFWS is expected under the proposed conservation measures for some forest management activities. For four types of operations within LTFC (thinning, roads, blasting, and recreation), the conservation measures differ among alternatives, with some limiting DNR’s operational flexibility more than others. Alternatives B, E, and F generally allow more flexibility and site-specific assessments (with consultation where necessary) to avoid habitat impacts. However, F would restrict harvest operations on the greatest number of acres and would subject the greatest number of acres to site-specific consultation. Alternatives C and D would prohibit new road and new recreation facility development in marbled murrelet conservation areas and propose more restrictions on where thinning and blasting activities can occur.

5) **Implementation Certainty: Adopt feasible, practical, and cost-effective actions that are likely to be successful and can be sustained throughout the life of the HCP.**

The action alternatives all share a feasible, practical, and cost-effective basic approach to conservation by increasing certainty about where and how much marbled murrelet habitat will be conserved over time and by building a strategy around areas that are already deferred from harvest by existing DNR policies and regulations. Lands already assumed to be unavailable for harvest make up the majority of the proposed marbled murrelet conservation areas, which will control DNR’s costs for implementing a long-term strategy. The conservation measures largely acknowledge the need for most DNR routine operations to continue to occur within LTFC and limit restrictions or prohibitions to within specific marbled murrelet habitat areas. This means that active management of forest resources could largely continue, following clear parameters for seasonal timing restrictions, disturbance buffers, and need for consultation. Thinning designed to accelerate habitat development under the alternatives would increase implementation costs for those alternatives. Alternative F allows the most thinning within marbled murrelet conservation areas (MMMAs). While the conservation measures common to the action alternatives all add some implementation cost and/or time delay for projects compared with the no action alternative, these impacts are not expected to be significant.

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Chapter 3

AFFECTED ENVIRONMENT

Chapter 3

Affected Environment

This chapter describes the current conditions for the elements of the natural and built environment most likely to be impacted by the proposed action. Current conditions are described so that an evaluation of potential impacts can be conducted in Chapter 4, Environmental Consequences.

Elements of the Environment

The purpose of this chapter is to describe the elements of the natural and built environment within the analysis area, which is defined as all DNR-managed lands within 55 miles of all marine waters in western Washington (refer to Figure 1.3.1 in Chapter 1) that could be affected by the proposed alternatives. Each section will describe a different element of the environment, its current condition on the landscape, and the policy and regulatory context for management of the element. The environmental impacts of the action alternatives on these current conditions are analyzed over time in comparison to the no action alternative (refer to Chapter 4, Environmental Consequences).

SEPA and NEPA provide guidance on what elements to consider in environmental impact statements.[1] Only those elements of the environment most likely to be impacted by the proposed action are included in this chapter. Elements were chosen based on the likelihood of impact and from information gathered during the scoping process (as described in Chapter 1 and summarized in Appendix A). The following elements will be described in this chapter and analyzed for potential impacts in Chapter 4:

- Earth (geology and soils)
- Climate
- Vegetation
- Aquatic Resources (water, riparian habitats, and fish)
- Wildlife and Biodiversity
- Marbled Murrelet
- Recreation
- Forest Roads
- Public Services and Utilities
- Environmental Justice*
- Socioeconomics*
- Cultural Resources

* Those elements with an asterisk must be addressed under NEPA but not under SEPA.

[1] WAC 197-11-444, 40 CFR 1508.14.

The Joint Agencies determined that the following elements of the environment would not be analyzed in this DEIS because of the low likelihood of impacts:

Element of the environment	Findings
Air quality (other than climate)	No new emissions or increases in emissions of pollutants that could affect air quality are proposed under the alternatives.
Visual/scenic resources/light and glare	None of the alternatives will affect scenic views. All alternatives set aside forested lands for conservation additional to the acres that currently provide scenic views.
Water: Runoff/absorption/flooding/groundwater and public water supplies	Increasing forested acres set aside for conservation has no anticipated impact on runoff or absorption. Water quality impacts are addressed in Aquatic Resources section. No public water supply sources will be affected by the proposal or any alternatives.
Traffic and transportation	Only forest roads and associated infrastructure are evaluated. The proposal will not impact traffic or transportation on public roadways. Recreational trails will be analyzed in the DEIS.
Noise	None of the alternatives include activities that would increase or cause new sources of noise. Ongoing noise from forest management activities is addressed by conservation measures; the effects of noise disturbance on murrelets is discussed in Section 4.6.
Urban land uses (including population and housing impacts), sewer, solid waste	The conservation strategy alternatives all take place in non-urban environments. No urban land uses will be affected. Impacts to trusts (which fund some urban services) will be analyzed under Sections 3.11 and 4.11, Socioeconomics.
Environmental health	No activities proposed by any alternative would impact environmental health generally. Impacts to water quality and quantity will be addressed.
Agricultural lands/crops	There are no significant agricultural lands within the analysis area.

Data sources

DNR's 2015 large data overlay is the primary source of data for describing the current conditions of each element of the environment. Additional databases maintained separately by DNR or other federal, state, or local sources were also used as appropriate. Previously adopted plans, policies, and regulations are also sources of data for describing each element of the environment. Expert knowledge from DNR staff is also a source of information for describing the policy and regulatory context for each element of the environment.

Scope and scale of analysis

The analysis area can be broken up into subareas for purposes of describing different elements of the environment. Some elements are best described at larger scales, such as the entire analysis area or planning units. Other elements might be described at a county or other subarea level. Decisions about the appropriate scope and scale of analysis to use relate to the types of data available and the context and intensity of potential impacts. Each section will be explicit about the scope and scale of analysis used to describe the element of the environment.

It is important to recognize that these SEPA and NEPA analyses are for the purpose of amending the 1997 HCP with a long-term marbled murrelet conservation strategy. There are no changes proposed to the other 1997 HCP conservation strategies or how their objectives are to be accomplished. The objectives and conservation strategies for northern spotted owls (DNR 1997, p. IV.1), the objectives and conservation strategies for riparian habitats (DNR 1997, p. IV.55), the integrated approach to production and conservation for the Olympic Experimental Sate Forest (DNR 1997, p. IV.81), and the multispecies conservation strategy for the OESF (DNR 1997, p. IV.134) and the west-side planning units (DNR 1997, p. IV.145) would remain unchanged under this proposed amendment. The only 1997 HCP conservation strategy change being considered is replacing the interim strategy with a long-term conservation strategy for the marbled murrelet.

3.1 Earth: Geology and Soils

This section provides a brief description of geology and soils within the analysis area and how DNR manages these resources.

Why are geology and soils important?

The marbled murrelet long-term conservation strategy depends on sustainable, mature forests to provide long-term nesting habitat. Healthy soils are a foundation of healthy, productive forests. Understanding how the alternatives could potentially affect soil stability, erosion, and productivity is an important part of determining environmental impacts.

Current conditions

The soils and geology of DNR-managed lands within the analysis area have been previously described in several DNR documents, including the *South Puget Forest Land Plan* (DNR 2010), *Sustainable Harvest Calculation Final Environmental Impact Statement* (DNR 2004), the *Final Environmental Impact Statement for the Proposed Issuance of Multiple Species Incidental Take Permits* or 4(d) Rules for the *Washington State Forest Practices Habitat Conservation Plan* (Chapter 3.4, NMFS and USFWS 2006), and Appendix B of the *Forest Practices Board Manual*, Section 16 (DNR 2016c). These conditions are briefly summarized here.

Soil characteristics vary throughout the analysis area because of the diversity of soil-forming factors. The type of parent material (mineral or rock material from which a soil develops) largely determines the susceptibility of the resulting soil to land use impacts.

In the Puget Lowlands and North Cascade Foothills, past glaciation has formed thick layers of fine-grained glacial lake sediments, coarse-grained outwash, and till. Much of these sediments are very compact, having been overridden by thousands of feet of ice. Glacial meltwater and river and marine erosion have left over-steepened slopes on the margins of river valleys and marine shorelines, which are often highly susceptible to a great variety of landslide types.

Rock falls and complex rock slides are dominant in the steep bedrock slopes of the North Cascades. In the South Cascades, shallow landslides generating debris avalanches and flows are common on steeps slopes and drainages. Soils on mountain slopes and ridge tops can compact easily because of coarse textures. Volcanic ash is a common parent material and compacts easily when wet.

On the Olympic Peninsula, lowlands and major river valleys are underlain by sediments derived by glaciations, which are in turn underlain by very weak sedimentary and volcanic rocks. Large landslide complexes are widespread along Hood Canal and lower reaches of the major river valleys. Landslides are also abundant in the very weak marine sedimentary rocks in western and northwestern portions of the Peninsula.

In southwest Washington, which was largely never glaciated, soils are older, deeper, and finer than soils in the northern and Olympic regions. The Willapa Hills are comprised primarily of very weak marine sedimentary and volcanic rocks, with weak residual soils subject to widespread landslides. Thick and deeply weathered loess deposits along the lower Columbia River valley are subject to shallow landslides and debris flows.

Soil productivity

Soil productivity refers to a soil's capacity to support vegetation. Productivity depends on many factors, including amount of organic matter and organisms, density or porosity, and levels of carbon, nitrogen, and other beneficial nutrients. Processes affecting soil productivity include landslides, surface erosion, and soil compaction. These processes are described in detail in the *Final Environmental Impact Statement on Alternatives for Sustainable Forest Management of State Trust Lands in Western Washington* (DNR 2004) and are summarized briefly in this section as they relate to the proposed alternatives. Timber harvest and road-building activities can adversely affect soil productivity by compacting soils, changing soil temperature, removing organic layers, changing nutrient dynamics, or increasing the risk of landslide or surface erosion.

Surface erosion

Forest practices, including harvest activities, timber hauling, and road construction, can be a source of sediment delivery to aquatic resources when they loosen or disturb sediments near or upslope of aquatic resources. Forest vegetation stabilizes soils and reduces erosion, minimizing management-induced sediment delivery to aquatic resources. Surface erosion may also impact general forest productivity over long time frames.

Soil compaction

Water, air, and nutrients enter soils through pore spaces. Compaction is the loss of or decrease in pore space due to an external force, such as heavy machinery and road or trail construction and use. Compaction reduces the amount of water and nutrients that can be delivered to plants and also increases the risk of overland flow of water, resulting in erosion. Compaction can also result in shallow rooting, increasing the risk of wind throw or impacts of disease on forest stands.

Landslides

Landslides (also known as mass wasting events) are the movement of a mass of rock, debris, or earth down a slope caused by natural events such as high precipitation, river bank erosion, or earthquakes. Management actions such as timber harvest and road building on potentially unstable slopes can make them more susceptible to landslides.[2] Protection of potentially unstable slopes is a major consideration in DNR's planning for timber harvests, road building, and road removal because landslides pose significant risks to human safety, state trust assets, public resources, and overall forest productivity. DNR identifies and verifies areas of landslides and potentially unstable slopes on forested trust lands at the site scale during individual timber sale planning and layout. For landscape-scale planning projects, DNR uses the best available information from a variety of screening tools to estimate the occurrence of potentially unstable landforms. Screening tools include slope hazard models, watershed scale inventory data, Lidar, and other mapping tools. The features identified using these tools reflect where DNR suspects there could be potentially unstable slopes.

The availability and accuracy of screening tools varies across DNR-managed land. Inventory and remotely sensed data are intended to trigger field verification at the time of harvest planning. Field verification may find that no potentially unstable slope is actually present, may find new areas of potential instability, or may change the extent of the mapped hazard. Potentially unstable areas are present throughout the analysis area. In LTFC, a majority of the land identified as potentially unstable is already in a long-term deferral or conservation status.[3] Unstable slopes continue to be identified as screening tools are updated with remote sensing and field assessment.

Existing policies and regulations

DNR manages its forestlands to reduce the risk of increasing landslide potential, surface erosion and compaction, and loss of soil productivity.

All forest management activities occurring on DNR-managed lands must comply with *Washington's Forest Practice Rules* (Title 222 of the Washington Administrative Code (WAC)), which regulate all activities that would affect slope stability, erosion, and productivity. The *Washington State Forest Practices Board Manual*,[4] *Policy for Sustainable Forests*, and the 1997 HCP also guide DNR's management activities that may impact potentially unstable slopes and soils.

Regulating activities that can damage soils

Timber harvest, road and trail building, maintenance, and use can damage soils. DNR timber sales contracts include clauses requiring equipment limitations for timber harvesting to minimize or avoid soil compaction. The state forest practices rules and board manual are designed to ensure that DNR road construction, maintenance, and abandonment do not cause damaging soil erosion that will affect the stream network or contribute to the frequency or severity of slope failure. DNR's *Policy for Sustainable Forests* also sets the expectation that DNR will minimize the extent of the road network and that the

[2] The types of landslides commonly found in the analysis area are described in the *South Puget HCP Forest Land Plan* (DNR 2010, p. 78-79). How harvest and road-building activities relate to mass wasting are analyzed in Chapter 4 of the *Forest Practices Habitat Conservation Plan FEIS* (NMFS and USFWS 2006).

[3] Areas identified using the "UNSTABSLPS" field in DNR's large data overlay created in September 2015. The "UNSTABSLPS" field indicates the type/presence of an "important" unstable slope polygon originating from the Forest Practices Landslide Inventory and Hazard Zonation and DNR's Trismorph GIS layer.

[4] Refer to Section 3, Guidelines for Forest Roads, and Section 16, Guidelines for Evaluating Potentially Unstable Slopes and Landforms.

design, location, and abandonment of forest roads be carefully considered in regard to the impacts to the environment. Trail construction and maintenance follow U.S. Forest Service guidelines,[5] which are designed to minimize potential soil erosion. SEPA may require additional review of projects with potential operational effects on soil and water quality.

Preventing landslides in potentially unstable areas

For proposed timber harvests and road building projects, DNR geologists assist foresters and engineers in identifying and protecting areas that are potentially unstable to reduce the risk of management related landslides. When a DNR geologist identifies potentially unstable slopes in a proposed project area based on available screening tools such as GIS, aerial photos, or other data sources, he or she works with the forester or engineer to do a preliminary field visit and look for indicators of instability on the ground. During the field visit, the geologist assesses the risk of slope failure. If risks are deemed too high, the project will be halted or redesigned to avoid and mitigate the risks.

[5] Refer to *USDA Forest Service Standard Trail Plans and Specifications* (2014) and *Trail Construction and Maintenance Notebook* (2007).

3.2 Climate

This section describes the major drivers of climate change and how DNR-managed resources and other elements of the environment within the analysis area are expected to be impacted in conjunction with potential climate change.

Why is climate change important?

Forest resources are vulnerable to climate change. It is important to understand the potential effects of climate change on environmental conditions under a long-term conservation strategy. A long-term conservation strategy depends on structurally complex long-term forest cover, and it is therefore also important to understand how a change in DNR management activities proposed under the alternatives may or may not exacerbate potential effects from climate change.

Current conditions

Natural drivers alone cannot explain recently observed warming at the global scale (Gillett and others 2012). From reconstructions of past climates and climate models to current scientific understanding of how heat-trapping gases interact with the atmosphere, there are multiple lines of evidence that humans have been a primary driver of recent warming over the past 50 years and will continue to be the primary driver of climate change into the future (IPCC 2013, Walsh and others 2014). Most greenhouse gas (GHG) emissions from human activities have originated from the burning of fossil fuels. Deforestation (both the replacement of older forest with younger forests and forest conversion to non-forest) has also contributed to greenhouse gas emissions.

The Intergovernmental Panel on Climate Change (IPCC) released their fifth assessment report on climate change in 2013 (IPCC 2013). Within the report, the IPCC examined a range of trends in greenhouse gas concentrations, called representative concentration pathways (RCPs).[6] Unless otherwise noted, this DEIS reports on trends informed by two of these pathways, a pathway that assumes greenhouse gas emissions peak around 2040 before declining (RCP 4.5) and a pathway that assumes greenhouse gas emissions continue to rise throughout the century (RCP 8.5, Van Vuuren and others 2011).[7]

Standardized sets of RCPs in the IPCC report (IPCC 2013) are used to inform trends in general circulation models. These models incorporate our current understanding of key elements and drivers of the climate system to project future climate dynamics, such as trends in precipitation and temperature. Different general circulation models will model distinct climate trends even under the same RCP because all processes that drive climate are not completely understood, and each model uses different assumptions. For this reason, the discussion on projected future climate trends examines not only a range

[6] Each RCP describes a distinct, plausible climate future that varies in its assumptions of land use, population growth, economic development, and energy use and demand, among other considerations (IPCC 2013). In part, the intent of these futures is to help identify potential adaptation needs and strategies, and mitigation strategies, under a range of possible futures (Moss 2010).
[7] RCP 8.5 represents the current greenhouse gas emissions trajectory.

of RCPs where possible, but also a range of general circulation models. The majority of general circulation model trends described in the following section have been statistically downscaled to finer resolutions. Regional climate models, which use a dynamic downscaling method to better incorporate simulated general circulation models climate patterns with local terrain, are currently limited in the Pacific Northwest in part because of modeling cost. Consequently, the assessment exclusively relies on statistically downscaled general circulation models output. Although RCP and global circulation model outputs are produced for every year, projections for any given year are uncertain. Climate-related trends are therefore typically reported over 30-year periods, which is also what this DEIS uses to inform the analysis.

Future climate across the northwest is projected to be an exaggeration of current seasonal trends in precipitation and temperature (Rogers and others 2011, Mote and others 2013). All climate models project increases in temperatures throughout the year with warmest temperatures occurring during the summer months under both RCP 4.5 and RCP 8.5 for the 2041–2070 time period (Mote and others 2013). For the 2040–2069 period, the average air temperatures in the Puget Sound region are projected to increase 4.2°F under RCP 4.5 and 5.9°F under RCP 8.5 (Mauger and others 2015). Precipitation projections are less consistent with annual precipitation, varying from a 4.5 percent decrease to a 13.5 percent increase (Mote and others 2013). Yet whether annual precipitation increases, decreases, or remains at current levels, model projections of seasonal precipitation patterns show greater consistency: the majority of models project less precipitation during the summer and more precipitation in other months (Mote and others 2013, Mauger and others 2015). Along with these annual and seasonal trends, temperature and precipitation extreme events are also projected to increase by mid-century (Mote and others 2013). These trends in precipitation and temperature will likely have environmental and ecological consequences for many of the elements of the environment analyzed in this DEIS. These consequences are discussed in Chapter 4.2.

Effects of climate change on elements of the environment

The anticipated effects of climate change on DNR-managed elements of the environment within the analysis area are described briefly here in order to provide context for the question of how the proposed alternatives interact with a changing climate. This question will be examined in Chapter 4, Environmental Consequences.

VEGETATION

Forest conditions

Vegetation in Washington can be broadly classified as moisture- or energy-limited (Milne and others 2002, McKenzie and others 2003, Littell and Peterson 2005) in recognition of the role of climate in driving vegetation dynamics and bounding vegetation occurrences at broad spatial scales. Moisture-limited systems reflect forests where a lack of moisture constrains vegetation growth. Productivity in moisture-limited forests is likely to become even more limited as plant water needs is exceeded by available atmospheric and soil moisture (Littell and others 2010). Energy-limited systems typically reflect limitations to forests where light or temperature constrain vegetation growth. Examples in western Washington are those productive forests where cloud cover or competition limit available light for individuals and higher elevation forests where temperatures are colder. Productivity in energy-limited systems may increase at higher elevations as temperatures warm but could decline in lower elevations due to increased summer drought stress (Littell and others 2008). This potential shift in forest productivity illustrates how different factors (for example, energy and moisture) can limit vegetation within a species range and across seasons (Peterson and Peterson 2001, Stephenson 1990, 1998).

Plant species will respond individually to a changing climate, which will result in changes to plant communities. Both statistical and mechanistic models have been used in the northwest to examine trends in individual species (Littell and others 2010, Rehfeldt and others 2006) and broader vegetation types (Rogers and others 2011, Conklin and others 2015, Sheehan and others 2015, Halofsky and others forthcoming). All modeling efforts project drying in the Puget trough, but the amount of projected changes in species composition and/or structure vary by modeling approach, assumptions in how vegetation types may respond to changes in precipitation and temperature, and climate projections used. Those studies that cover all vegetation types in western Washington also project a decline in subalpine parkland[8] area due to increasing temperatures, decreased snow, and an upward elevation shift in tree line. Other vegetation types located below subalpine parkland and above the Puget trough will likely respond variably to a changing climate, likely declining in the lower portion of its existing range but also possibly expanding upwards in elevation. The timing of such changes is uncertain and will at least partially relate to annual and seasonal trends in temperature and moisture and the timing and frequency of stand-replacing disturbances (refer to next section). While such changes are less likely over the next decade, the risk that changes in forest composition will occur will increase with time.

Disturbances

Higher temperatures and/or below average precipitation can result in drought conditions, which can increase tree stress and mortality risk, reduce tree growth and productivity, and increase the frequency of drought-related disturbances such as insect and wildfire occurrence (Allen and others 2015, Littell and others 2016, Vose and others 2016). Drought can also influence the regeneration success of species, potentially resulting in novel forest assemblages (Vose and others 2016). As the seasonality, frequency, and intensity of drought changes with climate, drought severity could be amplified (Allen and others 2015), exacerbating physical plant responses and disturbance-related events, especially in moisture-limited systems. While future temperature projections for western Washington consistently project a warmer future, precipitation projections are less certain when viewed annually. Yet future precipitation patterns are more consistent when examined seasonally, typically projecting less precipitation during the summer (refer to preceding current conditions section for additional detail). It is therefore possible drought frequency and severity will also be greater in the future in western Washington. However, the timing and duration of such future potential events is unknown (days versus months or longer), and thus, the magnitude of effects on western Washington forests are uncertain.

In addition to drought, warmer temperatures and reduced summer precipitation will increase the likelihood of wildfire. Several studies project an increase in area burned under a changing climate (Littell and others 2010, Rogers and others 2011, Conklin and others 2015, Sheehan and others 2015, Halofsky and others forthcoming). All studies project at least a doubling in area burned relative to the historical fire

[8] Subalpine parkland is a high-elevation vegetation type without continuous tree cover.

return intervals,[9] even after accounting for some level of fire suppression. It is likely that future wildfires in western Washington will burn at a high severity given the fuel density found west of the Cascade crest and examples from the past in the paleo-record (Henderson and others 1989).

While wildfire is the primary mechanism of broad-scale forest renewal in western Washington, historically and currently, many west-side forests are more frequently disturbed by wind than wildfire. Near-surface wind speeds, which contribute to localized wind disturbance events, are generally projected to decline under RCP 8.5 (Luce and others 2013). There is little literature examining trends in episodic wind events, which disturb a larger area of the landscape in a short period of time. The only known study did not find a consistent trend in future episodic wind events for western Washington across ten general circulation models (Salathé and others 2015) suggesting future episodic wind events will become no more or less frequent than the past.

Broad trends related to forest diseases and climate are difficult to project because our current understanding of climate-pathogen relationships is limited, and climate-pathogen interactions are likely to be species and host-tree specific (Kliejunas 2011, Littell and others 2013). However, several studies have projected that the overall area suitable for beetle outbreaks is projected to decline (Hicke and others 2006, Littell and others 2010, Littell and others 2013). These projections indicated that beetle outbreaks will increase in frequency at higher elevations but decrease in frequency at lower elevations due to changes in year-round suitable temperatures for beetles and disruptions of life cycle events.

EARTH

As further discussed in the subsequent freshwater resources section, winter flood risk is likely to increase with higher projected winter stream flows (Hamlet and others 2013) and more frequent and more intense heavy rain events (Mote and others 2013). These same mechanisms, among other factors such as a decline in snowpack, will increase the conditions that trigger landslides (Salathé and others 2014, Mauger and others 2015).

AQUATIC RESOURCES

More precipitation falling as rain rather than snow, reductions in snowpack, earlier snowmelt, and reduced spring snowpack have all occurred over the last 50 years with increasing temperatures (Barnett and others 2008, Hamlet and others 2005, Hamlet and others 2007, Mote and others 2003, Mote and others 2005). Such trends are likely to continue with increasing 21st century temperatures.

The consequences of these trends will vary by watershed type. Hamlet and others 2013 classified most western Washington watersheds as either currently rain dominant or mixed rain and snow dominant. Rain-dominant watersheds produce peak flows throughout the winter months with little precipitation resulting from snow. Mixed rain- and snow-dominant watersheds typically have two peak streamflow periods: one occurring during the fall/winter months largely reflecting the precipitation falling as rain, and one in late spring/early summer mostly reflecting snow melt. With projected increases in winter precipitation, rain-dominant watersheds are expected to have little change to higher winter stream flows

[9] Historical fire return intervals for forests in western Washington range from 200 to over 1000 years depending on vegetation type.

(Hamlet and others 2013). Those watersheds Hamlet and others 2013 classified as historically mixed rain-snow watersheds in western Washington, primarily found on the west slope of the Cascade Mountains and northeast portion of the Olympic Peninsula, are projected to become rain dominant by the 2080s under moderate warming.[10] These mixed rain and snow watersheds are more likely to display changes in timing of peak flow with increasing temperatures (Elsner and others 2010) because of projected declines in snowpack, possibly resulting in a single, earlier peak streamflow period, similar to rain-dominant basins. In addition to timing changes, flooding magnitude and frequency are also projected to increase with time (Mauger and others 2015) with notable increases occurring in watersheds currently classified as mixed rain and snow (Mantua and others 2010).

Wetlands are expected to be sensitive to changes in climate given the relationship between wetland hydrology, structure, and function with temperature and precipitation (Carpenter and others 1992, Parry and others 2007). The timing and form of precipitation, increases in temperature, and increasing frequency of summer drought, among other factors, may all cause changes to wetland habitat (Lawler and others 2014).

Stream and wetland habitat for species, such as salmon, steelhead trout, and bull trout, are more likely to be impacted with changes in precipitation intensity, changes in flow regime, and stream temperatures. Warmer stream temperatures and lower summer flows will increase the thermal stress experienced by salmon and possibly increase the difficulty of migrating salmon to pass physical and thermal barriers (Beechie and others 2006, Independent Science Advisory Board 2007, Mantua and others 2010). An increase in winter flooding and mean flows could create negative impacts on salmon eggs through scouring (Mantua and others 2011) and possibly change the timing of life history events (Crozier and others 2011).

WILDLIFE

Similar to vegetation, wildlife species will respond individually to a changing climate with some species responding positively and other species negatively. Climate change will affect the physiology, distribution, and phenology of species resulting in direct effects on individual wildlife species as well as indirect effects through changes in wildlife habitat (Parmesan 2006, Parmesan and Yohe 2003). Across the northwest, amphibians and reptiles as a whole are considered more sensitive to climate change relative to birds, mammals, and plants based on a combination of both expert opinion and available literature (Case and others 2015). But individual species response will vary based on species sensitivity to habitat, disturbance regimes, and dispersal ability, among other factors (Case and others 2015). For example, some species that are generalists are considered less sensitive because they can easily disperse, use a variety of habitats and structures, and have a wide phenotypic plasticity, among other reasons (Lawler and others 2014).

Recent work by Case and others 2015 combined opinions from approximately 300 experts to assess the sensitivities of 195 plant and animal species to a changing climate across the northwest. According to a database created from the assessment,[11] the marbled murrelet, northern spotted owl, and Taylor's

[10] Hamlet and others 2013 used an emissions scenario called A1B1, which is older than the RCP emissions scenario used throughout this analysis. A1B1 results in more warming than RCP 4.5 but less than RCP 8.5.
[11] Refer to http://climatechangesensitivity.org.

checkerspot butterfly all received overall sensitivity scores of “high” based on a weighted average of sensitivity to eight individual factors (refer to Case and others 2015 for a list of factors). Overall expert confidence in their sensitivity assessment ranged from fair for the marbled murrelet and northern spotted owl to good” for the Taylor’s checkerspot butterfly. While the work examined species sensitivity, it did not address individual species vulnerability or risk to a changing climate. However, one of the eight sensitivities assessed by Case and others 2015 was habitat. All three species had the highest sensitivity score for habitat indicating experts felt all three species are habitat specialists and therefore have narrow habitat niches. Expert confidence in habitat sensitivity assignment ranged from very good (the highest confidence ranking) for the butterfly to good” (the second most confident ranking) for the murrelet and owl. Using data from Case and others 2015, *Washington’s State Wildlife Action Plan* (2015) examined individual species’ vulnerability, defined as the sensitivity and exposure of a species to climatic factors. Marbled murrelet and northern spotted owl respectively received moderate and moderate-high vulnerability scores, which in part reflect the habitat-specialist nature of both species.

Effects of DNR management on a changing climate

While DNR’s contribution to global emissions may be small, DNR’s possible contribution to a changing climate is considered here because “climate change results from the incremental additions of GHG emissions from millions of individual sources, which collectively have a large impact on a global scale” (CEQ 2016). Carbon is the leading type of greenhouse gas emitted.[12] Primary potential sources of carbon emissions from DNR-managed lands would originate from harvesting older forests (approximately more than 160 years old), shortening the age of DNR final harvest stands, and if volume removed by thinning in LTFC in stands without a final harvest was greater than residual stand volume growth. Additional carbon emissions occur from vehicle and equipment emissions related to all timber activities. Primary sources of carbon sequestration (capture and storage) on DNR-managed lands are tree growth and carbon storage in long-term wood products such as timber rather than paper products. Carbon sequestration in soils and release from soils via decomposition will vary depending on management intensity. Whether DNR-managed lands sequester and store more carbon than is emitted is analyzed in Chapter 4, Environmental Consequences.

Existing policies and regulations

A description of recommended climate change analyses was issued by the Council of Environmental Quality (CEQ) 2016 guidance in for NEPA analysis.[13] This guidance informs the analysis of environmental consequences in Chapter 4. DNR does not currently have a policy that specifically addresses climate change. Nonetheless, existing language in the 2006 *Policy for Sustainable Forests* (DNR 2006) provides silvicultural flexibility and both forest health and natural disturbance-response guidance that should facilitate an adaptive agency response to a changing climate.

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[12] Refer to www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data.
[13] Refer to www.whitehouse.gov/sites/whitehouse.gov/files/documents/nepa_final_ghg_guidance.pdf.

3.3 Vegetation

This section of the DEIS describes the current conditions of vegetation in the analysis area, including both general forest conditions as well as vegetation in special management or conservation status. Forest conditions directly related to climate change, riparian areas and wildlife habitat are described in other sections of this chapter.

Forest in the OESF. Photo: Richard Bigley

Why is vegetation important?

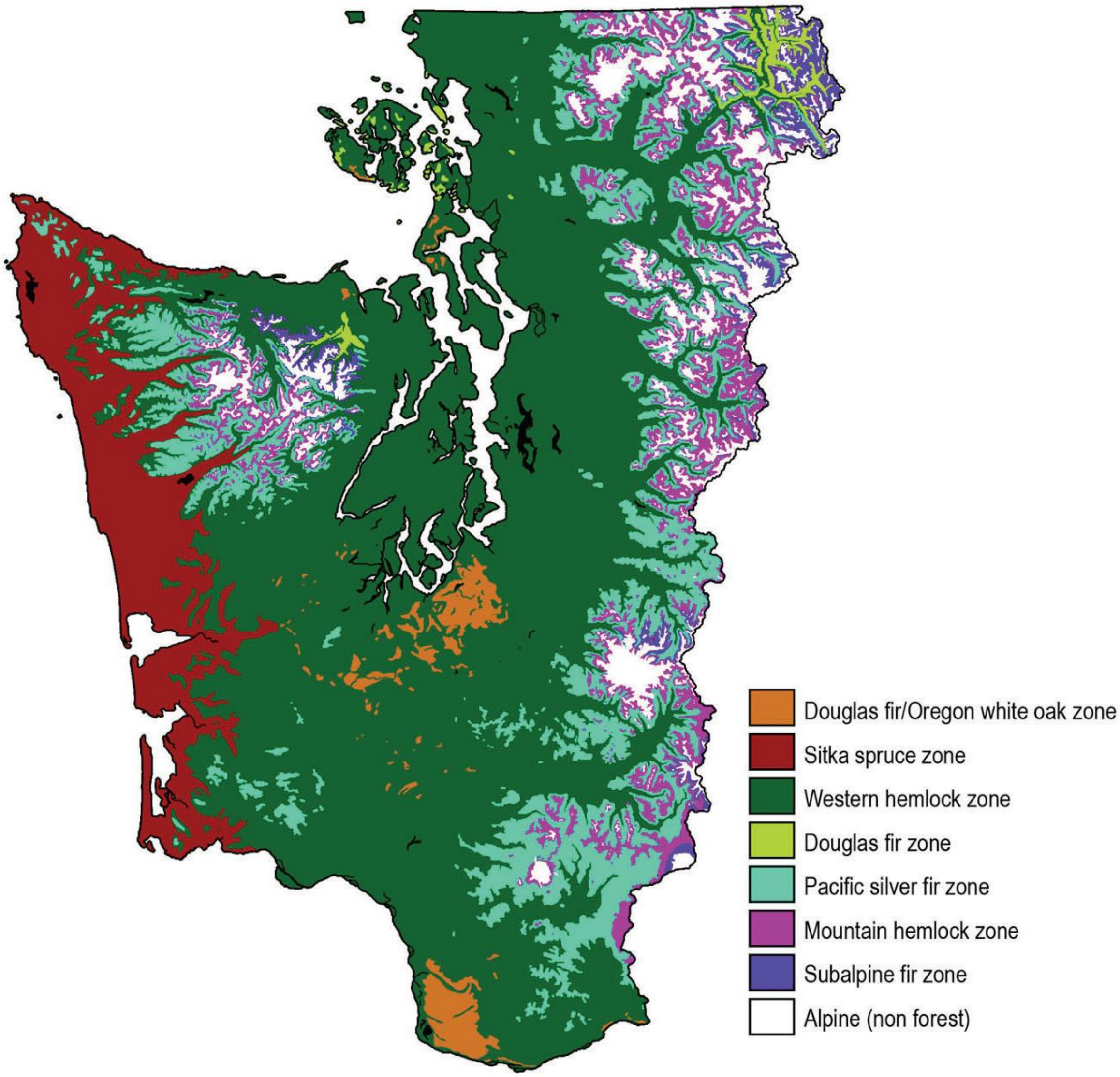
Areas of structurally complex, long-term forest cover provide potential nesting opportunities for the marbled murrelet. The proposed alternatives change the management of vegetation on a small percentage of forestlands in the analysis area in order to support the development and maintenance of this type of forest.

Current conditions

DNR maintains data from various sources on forest conditions in the analysis area. This section summarizes the existing conditions of forestlands in the analysis area in order to understand potential impacts from the alternatives.

The analysis area contains a great diversity of forested habitats. The steep, mountainous topography of western Washington has dramatic effects on precipitation and temperature. Accordingly, tree species have become stratified by their tolerance and competitive abilities. In *The Natural Vegetation of Oregon and Washington*, Franklin and Dyrness (1973) separate the region into vegetation zones based on the dominant tree species. In the simplest terms, western Washington can be divided into seven vegetation zones (Figure 3.3.1).

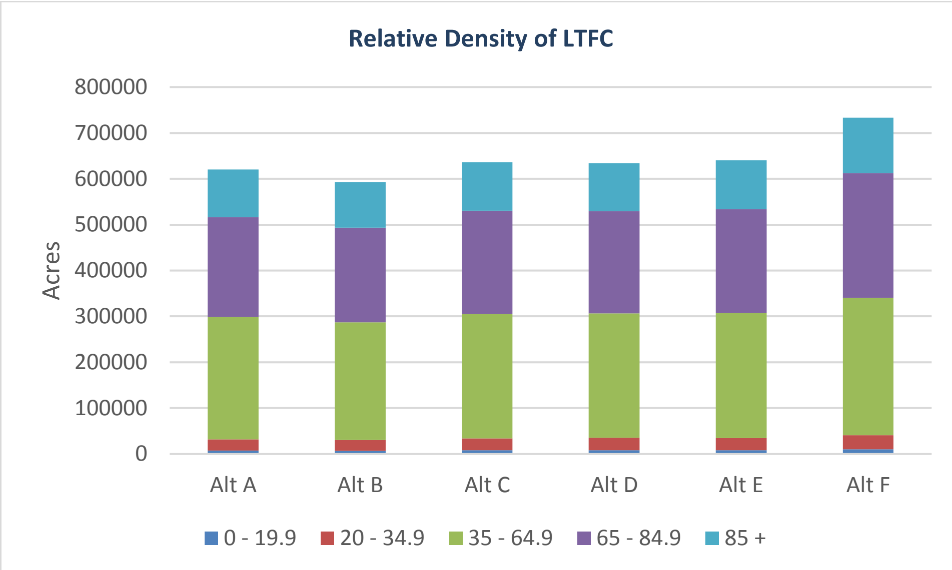
Figure 3.3.1. Potential Natural Vegetation Zones of Western Washington (Van Pelt 2007)



General forest conditions

Forests on DNR-managed lands in western Washington generally reflect a history of active timber harvest, however stands that have never been harvested still remain. Over 80 percent of DNR-managed forests in the analysis area are dominated by Douglas fir or western hemlock. Areas of LTFC are also dominated by these species, although with a higher proportion of western hemlock. Most forest stands within the LTFC have with a relative density below 85 (Curtis 1982), while between 16 and 17 percent of stands have relative densities over 85 depending on the alternative (Figure 3.3.2). High stand density can be related to increased risks from weather and disease in the presence of other risk factors, such as landscape position, soil, and climate (Powell 1999, Mitchell 2000).

Figure 3.3.2. Current Proportional Distribution of Acres in LTFC by Stand Density Class (Curtis' Relative Density), by Alternative



Forest health issues

DNR, in conjunction with the U.S. Forest Service, conducts annual aerial forest health surveys (Dozic and others 2015). The 2015 survey detected several sources of damage to forests in the analysis area, mostly from insect and bear damage (refer to Table 3.3.1). Several root diseases are common in western Washington and are likely present in LTFC. In order to address forest health issues, DNR manages its forest consistent with DNR's Policy on Forest Health (DNR 2006, p. 32), which includes strategies to adjust stand composition to favor species best adapted to the site, to incorporate other cost-effective forest health practices into the management of forested state trust lands, and to work closely with the scientific community, other agencies, and other landowners to effectively address forest health issues (DNR 2006, p. 32).

Table 3.3.1. Sources of Forest Damage in the Analysis Area (Dozic and Others 2015)

Source of Forest Damage Detected	Damaged Area
Douglas-fir beetle (*Dendroctonus pseudotsugae*)	615 acres
Damage from black bears (*Ursus americanus*)	~2 trees per acre over 19,000 acres
Swiss needle cast (*Phaeocryptopus gaeumannii*)	1,400 acres severe, 48,000 acres moderate
Douglas-fir engraver (*Scolytus unispinosus*)	170 acres
Fir engraver (*Scolytus ventralis*)	160 acres
Bigleaf maple dieback and decline (unknown agent)	90 acres
Pacific madrone decline (unknown agent)	6 acres

Table 3.3.2. Common Root Diseases in Western Washington (Dozic and Others 2015)

Disease name	Host species
Black stain root disease (*Leptographium wageneri*)	Douglas fir
***Armillaria* sp.**	All conifers
Laminated root rot (*Phellinus sulphurascens*)	Douglas fir
Annosus root disease (*Heterobasidion irregulare* and *Heterobasidion occidentale)*	All conifers

As described in Sections 3.2 and 4.2, a changing climate may bring increased disturbance events such as fire or disease, although trends are difficult to predict and may not necessarily increase during the planning period. Many of these disturbances are outside of DNR's management control, although the department does conduct forest health treatments to increase wind firmness and resilience to wildfire in some stands. Such activities are consistent with DNR policy. Section 4.2 discusses the potential for climate-related loss of forest structure in LTFC.

Vegetation in special management or conservation status

DNR-managed forestlands within the analysis area includes vegetation that is managed for conservation purposes pursuant to the 1997 HCP, DNR's *Policy for Sustainable Forests*, or state law. These lands are managed primarily to maintain habitat for protected species, biodiversity, or unique natural features of regional or statewide significance.

OLD GROWTH

DNR policy generally defers from harvest old-growth stands (stands 5 acres and larger that originated naturally before the year 1850), as well as very large-diameter, structurally unique trees. Old growth within the analysis area is included as LTFC under every alternative. According to DNR inventory information, there are approximately 88,000 acres of potential old growth in western Washington, with 60 percent of those acres demonstrating a high potential to be old growth (DNR 2005).

GENETIC RESOURCES

DNR protects the genetic resources of its native tree populations by maintaining a system of gene pool reserves, which are included as LTFC. These reserves are generally located in forestlands that are protected for other reasons (as unstable slopes, old growth, or riparian areas). Gene pool reserves are deferred from harvest under the *Policy for Sustainable Forests*. There are approximately 2,400 acres of gene pool reserves designated as LTFC under each alternative.

NATURAL AREAS

As described in Chapter 1, DNR manages two types of natural areas defined by state law: Natural Area Preserves (NAPs) and Natural Resource Conservation Areas (NRCAs). These areas protect native ecosystems, rare plant and animal species, or unique natural features. Both types of natural areas are covered under the HCP and are included as LTFC for this DEIS. NAPs are managed under the *State of*

Washington Natural Heritage Plan, and some NAPs also have site-based management plans. The NRCAs are managed under the *NRCA Statewide Management Plan* or individual management plans.

Natural areas are managed for primarily for the protection of important biological or ecological resources, including plant communities that are in good to excellent ecological condition and some examples of mature forest. Research, environmental education, and low-impact recreation activities also occur on these lands. Natural areas are protected under state law from conversion to non-conservation uses. A summary of the status and management of these lands can be found in the 2014 *State Trust Lands HCP Annual Report* (DNR 2015).

There are approximately 85,000 acres of forested natural areas within LTFC. Some of these natural areas maintain marbled murrelet habitat by protecting late-seral forests with potential nesting platforms. Natural areas managers work with DNR biologists and consult with USFWS as necessary, to avoid, minimize, and mitigate potential impacts from activities or projects in marbled murrelet habitat. Such activities can include new recreational facilities or forest restoration.

RARE PLANTS AND HIGH-QUALITY ECOSYSTEMS (SPECIAL ECOLOGICAL FEATURES)

The *Policy for Sustainable Forests* specifies that DNR will identify forested state trust lands with "special ecological features" of regional or statewide significance. This task is informed by Washington's *Natural Heritage Plan* (2007, updated 2011), which identifies and prioritizes plant species and ecosystems for conservation. Rare plants and high-quality ecosystems are priorities for inclusion as natural areas. DNR's Natural Heritage Program maintains a comprehensive database on rare plant species, communities, and their locations. The database of known locations is consulted by DNR's regional foresters when planning timber sales activities, with the intent of avoiding impacts to special ecological features. 34 species of rare plants are currently known to occur within LTFC under any alternative (refer to Appendix K for a list of species).

Federally listed threatened plants within the analysis area include water howellia and golden paintbrush. The habitat of these plans is covered under the 1997 HCP, but they are not known to occur in forested habitat on DNR-managed lands.

PLANTS ASSOCIATED WITH UNCOMMON HABITATS

DNR's conservation strategies in the 1997 HCP provide measures to protect wildlife species that rely on uncommon habitats or uncommon habitat elements (DNR 1997, p. IV.151). These measures specifically protect features such as talus, caves, cliffs, oak woodlands, large snags, and large structurally unique trees. These uncommon wildlife habitats are included as LTFC and provide conditions for different types of vegetation, and in some cases, unique vegetation. Oak woodlands, composed of the only native oak in Washington, the Oregon white oak, have been designated a priority habitat by the Washington Department of Fish and Wildlife. Talus and cliffs can provide conditions for pioneering vegetation, while cliffs provide conditions for shade tolerant vegetation. DNR's regional foresters consult with staff biologists when planning timber sales activities with the intent of conserving these features.

3.4 Aquatic Resources

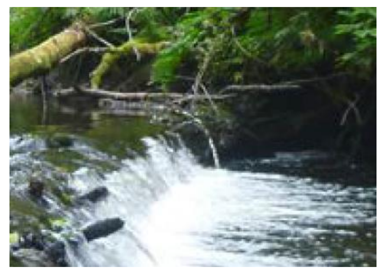
This section describes the existing conditions of riparian habitat, wetlands, water quality and quantity, and fish populations and habitat within the analysis area, which this DEIS refers to collectively as aquatic resources.

DNR and USFWS often consider these elements of the environment individually when reviewing proposed actions. However, for this DEIS, the Joint Agencies are considering these elements collectively because they would all be affected by the alternatives in similar ways, by similar means, and to similar degrees.

Why are aquatic resources important?

Aquatic resources provide a valuable suite of functions and ecosystem services, improving water quality and providing fish and wildlife habitat. DNR's management philosophies are based largely on the underlying approach that maintaining the hydrologic functions of wetlands and riparian areas is essential to maintaining the health and function of forest ecosystems on state trust lands (DNR 2006, p. 36). All forested aquatic resources in the analysis area are considered part of long-term forest cover.

Text Box 3.4.1



What is riparian habitat?

Riparian habitat is located where land and water meet along the edges of streams and lakes.

Riparian areas include stream banks, adjacent floodplains, wetlands, and associated riparian plant communities.

Water quality and quantity are directly related to riparian function, as are fish populations and habitats.

Current conditions

Riparian and wetland habitat

Approximately one-third of all DNR-managed lands within the analysis area is forested riparian or wetland habitat. This habitat was modeled by applying the 1997 HCP riparian management buffers to DNR stream and wetland data. Forested areas within these modeled buffers were designated as long-term forest cover under each alternative.

Waters

RIVERS AND STREAMS

The *Policy for Sustainable Forests* (DNR 2006) and 1997 HCP include protection for Type 1 through 5 streams.[14] The level of protection is based on the specific nature of the stream channel and its position relative to fish-bearing stream habitat.

WATER QUALITY

Washington State Department of Ecology's *Water Quality Assessment* lists the water quality conditions for water bodies in the state, as required under Sections 303(d) of the Clean Water Act (Ecology 2016). Not all streams have been assessed for this list, and forest streams are generally not a priority for 303(d) listing due to the regulatory framework in place to protect water quality in working forests. Only localized areas of non-compliance (or inconsistent compliance) with water quality standards are listed for state trust lands. For example, on the OESF, out of nearly 3,000 miles of streams on state trust lands, only 10 miles are on the 303(d) list for failure to consistently meet the criteria for stream temperature, dissolved oxygen, turbidity, or fecal coliform bacteria (DNR 2013).

WATER QUANTITY

Timber harvest and associated roads can increase stormwater runoff that is delivered to rivers, streams, and wetlands. Peak flows and discharges are of greatest concern; these occur within the analysis areas primarily during fall and winter, when Pacific storms deliver large amounts of precipitation to the region. DNR minimizes the effects of peak flows through watershed-level planning and operating procedures. DNR ensures that sufficient amounts of hydrologically mature forest is maintained in each watershed to prevent detectable increases in peak flows that could impact water quality.

Fish

At least nine native species of resident and anadromous salmonids occur in rivers and streams crossing DNR state trust lands in the analysis area (NMFS and USFWS 2006, Table 3-21). In addition, several salmonid species in the analysis area are currently listed under the ESA. Numerous other native fish species are also distributed in waterbodies throughout the analysis area, including minnows, suckers, sculpins, and three species of lamprey. Appendix J contains a list of these species and their general distribution within the analysis area.

[14] DNR types streams based on *Washington Forest Practices Board Emergency Rules* (stream typing) from November 1996, reproduced in PR-14-004-150.

Existing policies and regulations

Forest Practices Rules

All forest management activities on non-federal lands in Washington are regulated under the state *Forest Practices Rules* (WAC Title 222). The rules establish standards for forest practices such as timber harvest, pre-commercial thinning, road construction, maintenance and abandonment, hydraulic projects (water crossing structures), and fertilization and forest chemical application. Many of these standards serve to protect aquatic resources.

The rules allow landowners with an HCP to be exempt from certain sections if they apply protections that will achieve at least the same level of protection as the rules. DNR applies its 1997 HCP riparian conservation strategies, described in the following section, for several activities, including delineating riparian management zones.

Text Box 3.4.2

How are aquatic resources managed?

Aquatic resources on DNR-managed lands are protected by an extensive framework of regulations, policies and plans.

This DEIS considers these existing protections when evaluating potential adverse effects of the alternatives on aquatic resources.

Riparian conservation strategies

For state trust lands, riparian conservation is implemented through two riparian conservation strategies in the 1997 HCP. One strategy applies specifically to the OESF planning unit, and another applies to the remaining west-side planning units ("west-side strategy").

Both strategies establish riparian management zones (RMZs) to protect salmonid-bearing streams and some non-fish-bearing streams. The OESF riparian strategy uses a watershed analysis approach to achieve riparian restoration objectives set by the 1997 HCP. Some limited harvest, including thinning, can be permitted in riparian zones, depending on this watershed analysis. The west-side strategy is supported by a Riparian Forest Restoration Strategy (RFRS) that provides direction on how to develop site-specific riparian forest prescriptions to achieve desired future conditions on stream reaches.

The 1997 HCP also does not allow variable retention harvest[15] of forested wetlands; thinning is permitted in the wetland management zone.

[15] Refer to Chapter 7 for definition.

3.5 Wildlife and Biodiversity

The section describes wildlife species and overall wildlife diversity of the analysis area.

Why is wildlife important?

Many of the species associated with the habitat provided in long-term forest cover, while not particularly rare, are nevertheless important for recreational, economic, cultural, and ecological values. LTFC also includes the habitat of some species listed under the Endangered Species Act, which are covered by the 1997 HCP.

Black bear. Photo: WDFW

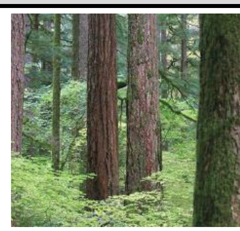
The analysis area has a variety of forested habitats that support these species, with some variability in the amount and distribution of this habitat depending on the alternative. This section describes the current species and overall wildlife biodiversity within the analysis area. Special emphasis is given to a discussion of northern spotted owls (*Strix occidentalis caurina*), whose habitat overlaps significantly with marbled murrelet nesting habitat.

Current conditions

Wildlife habitat

DNR classifies forested stands into “stand development stages” that represent the general progression of growth and structural development that any particular stand of trees goes through over time. Table 3.5.1 summarizes these stages and the number of wildlife species closely associated with them. The greatest diversity and abundance of wildlife occurs in the early ecosystem initiation stage and in the later structurally complex stages (Johnson and O’Neil 2001, Carey 2003).

Table 3.5.1. Stand Development Stages and Associated Wildlife Species Diversity

Stand development stage[a]		Approximate acres within the analysis area	Number of species closely associated with stage[b]
Ecosystem Initiation Begins soon after most overstory trees have been removed by harvest or natural events. This stage is known to support a high number of wildlife species, particularly as foraging habitat.		134,000	70
Competitive Exclusion Trees fully occupy the site, competing for light, water, nutrients, and space. Dense overstory means there are few or no shrubs or groundcovers and relatively little wildlife use.		1,066,000	6
Understory Development Overstory trees die, fall down, or are harvested, creating gaps in the canopy. An understory of trees, ferns, and shrubs develops. This process can be accelerated through active management.		64,000	6
Biomass Accumulation Numerous large overstory trees rapidly grow larger in diameter, producing woody biomass. Forest stands lack large snags or downed woody debris in this stage.		26,000	11
Structurally Complex Approaching conditions of natural older forests with multiple tree and shrub canopy layers, dead and downed logs, and well-developed understory. Multiple tree canopies are present, supporting diverse vertebrate and invertebrate species.		86,000	70

[a] Adapted from OESF RDEIS, p. 3-26.

[b] Habitat associations are based on Brown 1985 and Johnson and O'Neil 2001.

Thinning is a silvicultural strategy that DNR uses to move dense stands (stands in the competitive exclusion stage) into more structurally complex forests. Thinning dense stands of relatively low value wildlife habitat can expedite the transition over time into more variable stands containing physical elements important to forest wildlife, including snags, large trees, and diverse shrub and ground covers.

Wildlife species

This section describes wildlife species "guilds." A guild is a group of species utilizing the same class of resources in a similar way. It is hypothesized that these groups of species could be affected in similar ways by the alternatives. In addition, this section describes wildlife species that are especially important to consider because of their sensitivity to disturbance, low population levels, and/or recreational, commercial, cultural, and ecological values.

WILDLIFE GUILDS

This DEIS uses wildlife guilds to describe species that will be most affected by various forest conditions expected to be created or altered by the alternatives. The guilds, which are based on habitat associations described by Brown 1985 and Johnson and O'Neil 2001, are as follows:

- *Early successional guild* is composed of the many species that are associated primarily with very young forest stands (ecosystem initiation stage), including deer, elk, and several species of bats, small mammals, and migratory songbirds.
- *Late successional guild* is composed of species that are primarily associated with the structurally complex forest stage. Representative species include the northern goshawk, northern pygmy owl, brown creeper, Vaux's swift, Townsend's warbler, northern flying squirrel, and black bear (for denning).
- *Edge guild* is composed of species that use the edges between early and competitive exclusion and later stage forest stands. Representative species include the red-tailed hawk, great horned owl, Cascades fox, and mountain lion.
- *Interior guild* is composed of species that avoid edges or otherwise require large blocks of interior forest. Representative species include the pygmy owl and several species of migratory songbirds.
- *Riparian guild* is composed of species closely associated with streams and nearby upland habitat. Representative species include several species of amphibians and migratory songbirds, as well as aquatic mammals such as minks and beavers.

STATE-LISTED, CANDIDATE, SENSITIVE AND REGIONALLY IMPORTANT SPECIES

Appendix L provides a list of state-listed, candidate, and sensitive species present within the analysis area and their primary forest habitat associations. Appendix L also provides a table of species of regional importance, including those species that are important for recreational, commercial, cultural, or ecological values. This DEIS focuses on those species of state and regional importance that are highly dependent on specific forest conditions that may vary among the alternatives.

FEDERALLY LISTED SPECIES IN THE ANALYSIS AREA

Several federally listed terrestrial species are found in forested habitats or openings within forested areas in the analysis area. The species in Table 3.5.2 occur, or may occur, on HCP-covered lands within the analysis area. (Fish species are discussed in Section 3.4, Aquatic Resources.) The 1997 HCP provides conservation for these species. These species are currently covered or are likely to be covered under the HCP in the near future.

Table 3.5.2. Terrestrial Wildlife in the Analysis Area Listed as Threatened or Endangered Under the Endangered Species Act

Category	Species	Listing status
Mammals	Columbian white-tailed deer (*Odocoileus virginianus leucurus*)	Endangered
	Gray wolf (*Canis lupus*)	Endangered
	Grizzly bear (*Ursus arctos horribilis*)	Threatened
	Mazama pocket gopher (*Thomomys mazama subspecies*)	Threatened
Birds	Streaked horned lark (*Eremophila alpestris strigata*)	Threatened
	Northern spotted owl (*Strix occidentalis caurina*)	Threatened
	Marbled murrelet (*Brachyramphus marmoratus*)	Threatened
	Snowy plover (*Charadrius alexandrinus nivosus*)	Threatened
	Western yellow-billed cuckoo (*Coccyzus americanus*)	Threatened
Amphibians	Oregon spotted frog (*Rana pretiosa*)	Threatened
Invertebrates	Oregon silverspot butterfly (*Speyeria zerene hippolyta*)	Threatened
	Taylor's checkerspot butterfly (*Euphydryas editha taylori*)	Endangered

The 1997 HCP covers DNR forestlands within the range of the northern spotted owl. The HCP is a multispecies conservation strategy with the current incidental take permit (ITP) covering several listed species. Within the six west-side planning units, newly listed species under the ESA can be added to DNR's ITP (HCP B.12).

Northern spotted owl

The northern spotted owl was listed as threatened under the ESA in 1990 (55 FR 26114) because of widespread loss of habitat across the spotted owl's range. More recently, and based on the best available scientific information, competition from the barred owl (*Strix varia*) poses a significant and complex threat to the spotted owl (*Revised Recovery Plan for the Northern Spotted Owl*, USFWS 2011). The 1997 HCP covers the northern spotted owl and has a comprehensive approach to conserving the spotted owl on DNR-managed forestlands.

The 1997 HCP conservation objective for the northern spotted owl is to provide habitat that makes a significant contribution to demographic support, maintains species distribution, and facilitates dispersal (DNR 1997, p. IV.1). In the five west-side planning units (not including OESF), these objectives are accomplished primarily through the designation of dispersal areas and designation of nesting, roosting, and foraging areas (NRF areas). In areas designated to provide nesting, roosting, and foraging habitat, DNR shall provide at least 50 percent habitat (DNR 1997, p. IV.4). In areas designated to provide dispersal support, at least 50 percent shall be in a dispersal habitat condition (DNR 1997, p. IV.9). A detailed accounting of the status of habitat within NRF nesting, roosting, and foraging areas and dispersal areas is available in the 2015 DNR HCP annual report.

In the OESF planning unit, the conservation strategy for the northern spotted owl identifies landscapes for maintenance and restoration of northern spotted owl habitat (DNR 1997, p. IV.88). A detailed accounting of the current amount of habitat within landscapes is available in the 2015 DNR HCP annual report. The HCP directs that each landscape shall provide at least 20 percent old forest habitat and 40 percent young forest habitat or better.

Existing policies and regulations

The 1997 HCP

Conservation strategies described in the 1997 HCP are designed to conserve currently threatened and endangered species, and to help avoid future listing of other wildlife species (DNR 1997). Specific conservation strategies are included for: 1) northern spotted owls (DNR 1997, p. IV.1; for the OESF refer to p. IV.86); 2) riparian conservation that conserves salmonid freshwater habitat and other aquatic and riparian obligate species (DNR 1997, p. IV.55; for the OESF refer to p. IV.106); 3) marbled murrelets (DNR 1997, p. IV.39); and the multispecies conservation strategy for unlisted species (DNR 1997, p. IV.145; for OESF refer to p. IV.134). These various conservation strategies are intended to work together to accomplish the long-term multi-species conservation program.

Text Box 3.5.1

What are biodiversity pathways?

DNR policy is to use “biodiversity pathways” techniques—such as retaining trees and creating snags—to increase forest structure and associated wildlife habitat values in actively managed stands across the analysis area.

Policy for Sustainable Forests

The 2006 *Policy for Sustainable Forests* identifies biodiversity as one of the primary goals for landscape-level management of state trust lands (DNR 2006, p. 6).

The 2006 Policy also defines DNR’s general silvicultural strategy (DNR 2006, p. 46), which is to use “biodiversity pathways” to increase wildlife habitat values through active forest management, including the following:

- Retaining trees and snags (biological legacies) at harvest.
- Thinning to variable densities to encourage development of an understory.
- Improving habitat by creating snags and felling trees to create structure (DNR 2004).

3.6 Marbled Murrelet

This section briefly describes the biology and ecology of the federally listed marbled murrelet and the current habitat conditions, population, and regulatory status of the species.

Marbled murrelet at sea. Photo: DNR

Why is the marbled murrelet important?

Marbled murrelets spend most of their lives on the coastal marine waters from southern Alaska to central California. They are unique among seabirds because they nest inland from these waters in mature forests. Marbled murrelets do not build a typical nest; rather, they lay a single egg on a branch in the live crowns of coniferous trees. They use a variety of tree species, but in Washington, Douglas fir and western hemlock are the primary species where marbled murrelet nesting is found. Marbled murrelets have a tendency to return to the same nesting areas. Population declines in Washington are greater than in other parts of the species' range. The species was federally listed as threatened in Washington, Oregon, and California in 1992.

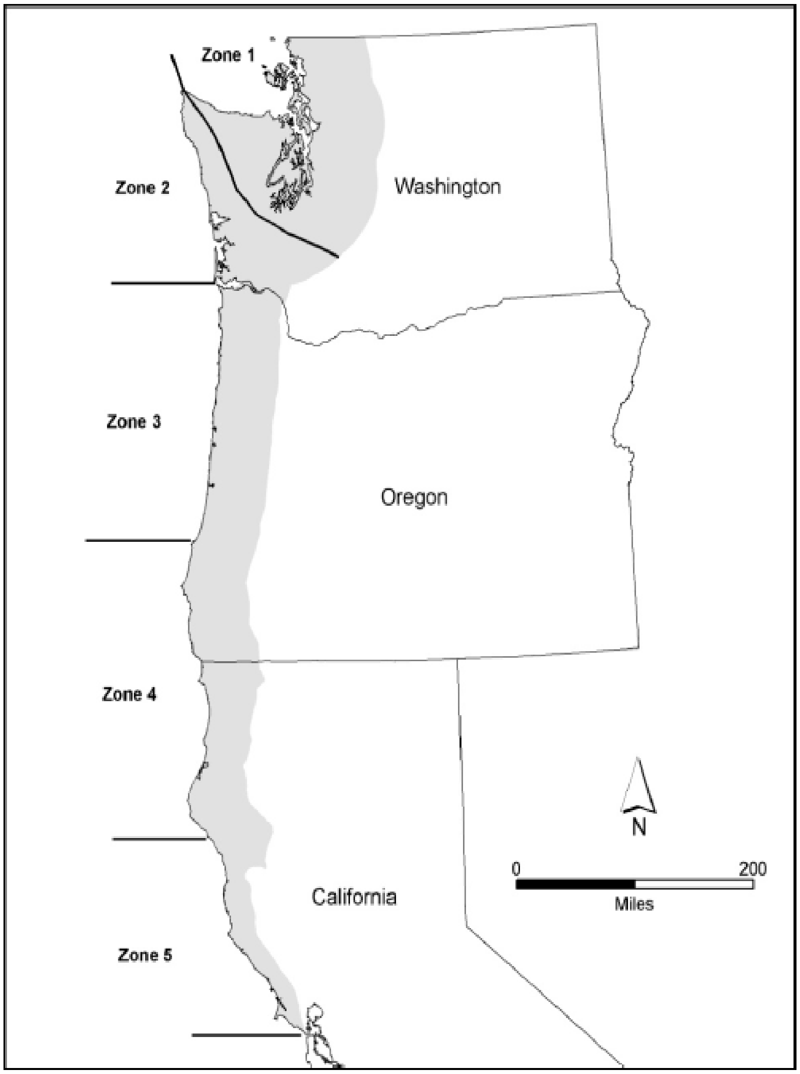
Current population trends and habitat conditions

This subsection presents information on the status and trends of marbled murrelet populations, as well as their inland and marine habitat and a brief summary of recent findings on their population ecology and habitat relationships. These summaries are largely based on several recently published reviews (McShane and others 2004, Huff and others 2006, Piatt and others 2007, USFWS 2009, Raphael and others 2011, COSEWIC 2012, Falxa and others 2016). Information on marbled murrelets and habitat in Washington includes findings from DNR-sponsored surveys and estimates of the distribution, quantity, and quality of marbled murrelet habitat on DNR-managed lands.

Population decline

The federally listed murrelet population in Washington, Oregon, and California is classified by the Service as a distinct population segment (75 FR 3424). Since 2000, this population has been monitored through the effectiveness monitoring program of the federal Northwest Forest Plan (NWFP). Researchers conduct annual at-sea murrelet surveys (Madsen and others 1999, Huff and others 2006, Raphael and others 2011, Falxa and others 2016) to estimate population size and trend across the plan area which encompasses five of the conservation zones in the marbled murrelet recovery plan (USFWS 1997) (refer to Figure 3.6.1).

Figure 3.6.1. Five of the Marbled Murrelet Conservation Zones (USFWS 1997) that are Monitored by the Northwest Forest Plan Effectiveness Monitoring Program.



Shaded area is overlap between Northwest Forest Plan area and breeding distribution area of the marbled murrelet. Copied from Falxa and others 2015 (p. 44).

The marbled murrelet population is declining in Washington. Examination of population trends by conservation zone suggest a clear decline in Washington's inner waters (Zone 1) and a possible decline in coastal waters of Zone 2 (Lance and Pearson 2016). The overall Washington murrelet population declined 4.4 percent per year 2001–2015 (Lance and Pearson 2016). There is no evidence of a declining trend in California or Oregon (Falxa and others 2016). Over all zones, Falxa and others 2016 estimated that the population declined 1.2 percent per year over the 2001–2013 period, but note that the evidence for a population decline at the scale of the entire NWFP is inconclusive. The NWFP area trend for this period differs from the population decline previously observed for the 2001–2010 period (Falxa and others 2016). This difference was the result of higher population estimates for 2011 through 2013 compared to previous years (Falxa and others 2016).

While the direct causes for marbled murrelet population declines are unknown, potential factors include the loss of nesting habitat, including cumulative and time-lag effects of nesting habitat losses over the past 20 years, changes in the marine environment reducing the availability and quality of prey, and increased densities of nest predators (Miller and others 2012, Falxa and others 2016). Recent analysis indicates that the amount and distribution of higher suitability habitat are the primary factors influencing the abundance and trends of murrelet populations. Habitat loss has occurred throughout the listed range of the murrelet, with the greatest losses documented in Washington, where the steepest declines of murrelet populations occurred (Raphael and others 2016).

MARINE CONDITIONS

Marbled murrelets face a variety of challenges finding food, avoiding predators, and surviving in their marine environment. Changes in prey abundance and availability are largely due to ocean conditions, harmful algal blooms, and degradation of prey resources from pollution, shoreline development, and fishing. Other human-caused risks to murrelets at sea include direct mortality from pollution, especially oil spills, and entanglement in fishing gear, also disturbance from vessel traffic and potential negative influences from anthropogenic global warming on marine ecosystems (Piatt and others 2007, USFWS 2009).

Although marine habitat challenges likely have contributed to marbled murrelet population declines, there is not a yet a body of science to clearly identify the primary cause of marbled murrelet population decline. From studies of marine populations of marbled murrelets and studies of inland forest conditions, scientists have inferred that the marine distribution of marbled murrelets during the breeding season appears to be substantially related to the abundance and proximity of large, contiguous patches of inland nesting habitat (Miller and others 2002, Piatt and others 2007, Raphael and others 2016).

AVAILABILITY OF INLAND NESTING HABITAT

Habitat characteristics important to the marbled murrelet include large nesting platforms on mature trees, adequate canopy cover, and sufficient interior forest to provide security. 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 (Raphael and others 2016).

Marbled murrelet egg in nest. Photo: Nicholas Hatch

Causes of habitat loss within the listed range

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 and others 2016). Habitat loss was greatest on non-federal lands, with a net 27 percent loss over twenty years, almost entirely due to timber harvest, while fire has been the major cause of nesting habitat loss on federal lands (Raphael and others 2016). While most (60 percent) of the potential habitat is located on federal-reserved lands, a substantial amount of nesting habitat occurs on non-federal lands (34 percent) (Raphael and others 2016).

Habitat models developed for the Northwest Forest Plan indicate approximately 1.3 million acres of potential nesting habitat in Washington. Most habitat occurs on federal lands managed under the

Northwest Forest Plan, while approximately 14 percent (187,000 acres) of the potential nesting habitat occurs on DNR-managed lands. Cumulative habitat losses since 1993 have been greatest in Washington, with a 13.3 percent decline over the monitoring period, with most habitat loss occurring on non-federal lands due to timber harvest (Raphael and others 2016). Currently, only about 12 percent of habitat-capable lands[16] in Washington contain potential nesting habitat for the marbled murrelet.

As described briefly in Chapter 2 and with more detail in Appendix F, DNR developed a habitat classification model to identify potential nesting habitat on Washington state trust lands. The P-stage model was applied to all DNR-managed land within the analysis area using DNR forest inventory data from 2015. The P-stage model identified approximately 213,000 acres of habitat, 9 percent more than had been previously identified under the Northwest Forest Plan (Raphael and others 2016).[17]

Table 3.6.1. Distribution of Marbled Murrelet Habitat on DNR-Managed Land, by P-Stage Class and HCP Planning Unit in October 2015

HCP planning unit	P-stage (acres)								
	0	0.25	0.36	0.47	0.62	0.89	1	Total Habitat	Total Land
OESF	202,461	5,180	10,790	6,587	5,283	880	39,611	68,331	270,791
Straits	109,338	6,604	2,174	614	927	19	5,661	16,000	125,338
North Puget	361,548	30,377	14,100	5,061	5,625	21,279	5,583	82,025	443,573
South Puget and Yakima	162,768	8,061	4,171	1,538	1,746	352	575	16,442	179,210
Columbia	85,793	4,810	4,967	370	169	2	2,699	13,016	98,809
South Coast	242,195	6,275	2,981	704	487	157	6,957	17,561	259,755
Total	1,164,102	61,307	39,183	14,873	14,238	22,689	61,085	213,375	1,377,477

As Table 3.6.1 illustrates, marbled murrelet habitat makes up approximately 15.5 percent of total DNR-managed land within the analysis area. This habitat is distributed throughout the analysis area. On the Olympic Peninsula (OESF and portions of Straits) and parts of the North Puget planning unit, DNR-managed lands are adjacent to federal reserves with extensive and abundant high-quality habitat. In southwest Washington (South Coast and Columbia planning units) these lands are embedded in extensive industrial forests with relatively scarce and fragmented murrelet habitat. Southwest Washington has been acknowledged as a priority area for murrelet habitat conservation (DNR 1997, USFWS 1997). In the Puget Trough lowlands there are marginal landscapes (portions of Straits, South Puget, and Columbia planning units; refer to Appendix H) where there is a much lower probability of marbled murrelet occupancy in DNR-managed forests.

[16] Habitat-capable land refers to areas within the Northwest Forest Plan boundaries capable of developing into forest.
[17] A discussion of how the P-stage model compares with other available habitat models is provided in Appendix E.

FACTORS INFLUENCING NEST SUCCESS

The ability of a marbled murrelet to successfully produce an egg and raise a chick is influenced by where the nest is located within the forest. A 5-year radiotelemetry study of marbled murrelet breeding ecology in Washington found only 4 of 20 nests were successful in a sample of 152 murrelets tagged near the Olympic Peninsula during the 2004–2008 breeding seasons (Bloxton and Raphael 2009). That success rate is consistent with other studies throughout the range (refer to, for example, Peery and others 2007, Barbaree and others 2014).

One factor found to contribute to failed nests is predation (USFWS 1997, McShane and others 2004, USFWS 2009). Although there is uncertainty about how key elements affecting nest predation interact, predator abundance, patterns of land use and cover, proximity and type of forest edge, and proximity to human-enriched food sources all appear to play a role in nest predation risk (USFWS 2009). Corvids (jays, crows, and ravens) are known predators of murrelet eggs and nestlings, and several species including the Steller's jay are more abundant in patchy, fragmented landscapes and/or in landscapes with higher levels of human use (Luginbuhl and others 2001, Raphael and others 2002, Neatherlin and Marzluff and others 2004, Malt and Lank 2009). Studies of simulated marbled murrelet nests have shown that proximity to early-seral forest edge, campgrounds, and small settlements are associated with higher levels of corvid use and predation (Marzluff and others 2004, Marzluff and Neatherlin 2004, Malt and Lank 2007). In addition to predation impacts, other human activities and land uses can disturb nesting marbled murrelets, which can affect their nesting success. These activities are summarized *in Appendix H* and are quantified in Section 4.6.

Edge conditions

A forest edge is an abrupt transition between two populations of trees, where the characteristics of the forest on one side are different from that of the other. Some edges are naturally occurring, created by wetlands, streams, or avalanche chutes, and others are created through human activity. Timber harvesting can create a high contrast edge along the boundary between the harvested area and the adjacent forested stands. Some types of forest edges increase the risk of disturbance to habitat and nest sites. Interior forests (forest stands at least 100 meters away from any non-forested area; refer to Chapter 2, Figure 2.4.4, and Appendix H) are better protected from the effects of predation and from many of the other disturbances that have been found to affect marbled murrelet habitat or nests. Changes to microclimate and the effects of windthrow are also greater near forest edges than within the forest interior. Edge categories are defined as follows: habitat over 100 meters from an edge is considered interior forest within 50 meters is outer edge, between 50-100 meters is inner edge, and all edge habitat and habitat not adjacent to interior forest is "stringer" habitat. The adverse impacts of edges are assumed to decline with distance from edge and as edge-creating stands mature (Appendix I). Table 3.6.2 summarizes the current edge conditions of potential marbled murrelet habitat on all DNR-managed land in the analysis area at the beginning of the planning period (referred to as "Decade 0" throughout this analysis). How these edge conditions affect habitat quality is analyzed in Section 4.6.

Table 3.6.2. Edge Condition of Existing Murrelet Habitat on DNR-Managed Land, Decade 0

Edge condition of habitat (acres with a P-stage value)				
Interior	**Inner edge**	**Outer edge**	**Stringer**	**Total**
80,827 (38%)	41,485 (19%)	48,485 (23%)	42,556 (20%)	213,352

Existing policies and regulations

Federal designation of critical habitat

Critical habitat for the marbled murrelet is designated on over 3.69 million acres in Washington, Oregon, and California (76 Federal Register 61599, Oct. 5, 2011). In Washington, the critical habitat designation includes over 1.2 million acres, located primarily on National Forest lands. In August 2016, USFWS published a determination confirming its previous critical habitat designations. [18]

In 1997, the USFWS completed a recovery plan for the marbled murrelet. The primary objectives of the recovery plan are: to stabilize and increase murrelet populations, changing the downward trend to an upward trend throughout the listed range; to provide conditions in the future that allow for a reasonable likelihood of continued existence of viable populations; and to gather the necessary information to develop specific delisting criteria. The Northwest Forest Plan (which includes critical habitat designated on federal lands) has been largely effective at conserving habitat on federal lands in Washington (Raphael and others 2016). Implementation of the Northwest Forest Plan, in conjunction with designation of critical habitat, has substantially decreased the rate of net habitat loss on federal lands, such that the net change in the amount of habitat on federal lands from all causes has been limited to just 6 percent of all net loss among all ownerships for Washington (Raphael and others 2016). However, the federal recovery plan (USFWS 1997) goal of stabilizing marbled murrelet populations in Washington has not yet been met.

Habitat conservation plans

Seven habitat conservation plans (HCPs) and two safe harbor agreements in Washington include the marbled murrelet as a covered species. HCPs that cover the marbled murrelet in Washington vary considerably in scale and scope of habitat protection for murrelets based on ownership objectives, forestry operations, capabilities, and geographic location. DNR's 1997 HCP is the largest in the state covering marbled murrelets.

[18] 81 Federal Register 51348 (Aug. 4, 2016)

State Forest Practices Rules

The Washington *Forest Practices Rules* (WAC 222) for marbled murrelets regulate timber harvest on private, state, county, and municipal lands. The rules require forest landowners to identify potential nesting habitat (as defined in the rules) where it exists and conduct protocol surveys to detect murrelets before any modification or alteration of habitat can take place. If surveys determine there is a high likelihood that nesting is present in a stand, the contiguous habitat is designated “occupied” and is held to a higher assessment level to assess any further likely adverse effects from management (i.e., Class IV Special review; DNR 1997a). Landowners that have ESA Section 10 permits for listed species receive take coverage that allows different management prescriptions than in the *Forest Practice Rules*.

Washington State listing and periodic status review

The marbled murrelet was listed as a threatened species by the Washington Fish and Wildlife Commission in 1993. It is currently undergoing a Periodic Status Review by the Washington Department of Fish and Wildlife (WDFW).[19] WDFW has recommended to the Fish and Wildlife Commission to change the listing status to “state endangered.” A decision on listing status is expected in late 2016.

Interim Strategy (no action alternative)

As described in Chapter 1, DNR implements an interim strategy under the 1997 HCP to protect marbled murrelet habitat on state trust lands. There are 401 occupied sites identified through audio-visual surveys on DNR-managed lands, but only 13 confirmed nest sites (see Appendix D). DNR designates and protects HCP-surveyed occupied sites and additional habitat areas identified under the HCP interim strategy from harvest. The distribution of protected habitat is mapped in Chapter 2 and Appendix F.

The no action alternative, Alternative A, is described in Chapter 2, and includes ongoing protection of HCP-surveyed occupied sites and buffers in addition to areas already in conservation status, plus additional habitat areas in all planning units. A variety of forest management activities are addressed in the 1997 HCP, including transportation system management, harvest and thinning, and other silvicultural practices. The 1997 HCP calls for development of a long-term strategy that will bring greater certainty to how and where habitat will be protected.

[19] WAC 232-12-297 (10.1)

3.7 Recreation

This section describes how DNR recreation lands are used and managed within the analysis area.

Why is recreation important?

Every year, there are an estimated 11 million visits to DNR-managed lands by people seeking a variety of recreational opportunities. There are numerous recreation lands located within areas designated as long-term forest cover. Recreation and public access are therefore important considerations when evaluating impacts to DNR-managed lands from the alternatives.

Current conditions

DNR's primary recreation focus is to provide a primitive experience in a natural setting through trails, water access, trailhead facilities, and rustic camping facilities. The department broadly categorizes recreation as either "developed" or "dispersed." Developed recreation occurs at DNR-managed recreation facilities and on DNR-managed trails. Dispersed recreation occurs outside of designated facilities and trails.

Text Box 3.7.1

What is the difference between developed and dispersed recreation?

Developed recreation occurs at DNR-managed recreation facilities and managed trails. Dispersed recreation occurs outside of these designated areas throughout DNR-managed lands.

Recreational use of DNR-managed lands, both designated and non-designated, is influenced by many factors. These include, but are not limited to, historic use of the area; topography of the landscape; presence of landscape features that are attractive to the recreating public; publicly accessible roads; the presence, density, and use intensity of facilities and trails (both designated and non-designated); proximity to population centers; forest management activities; enforcement presence; and adjacent landowners and land uses.

Types of facilities and trails

Statewide, DNR manages over 160 designated recreation facilities and over 1,100 miles of designated trails for both motorized and non-motorized uses. Designated facilities include trailheads, campgrounds, and day-use sites. Day-use sites are visited for a variety of activities including picnicking, environmental education and interpretation, paragliding and hang gliding, water access, and other activities

Picnic facility on DNR-managed forest. Photo: DNR

Trail through DNR-managed forest. Photo: DNR

where recreationists do not stay overnight. Trailheads provide access to DNR-managed trails and trail systems. Day use sites and trailheads often provide informational kiosks and toilet facilities. Campgrounds provide recreationists the opportunity to stay overnight in an area managed for camping and may also provide access to nearby trail systems. Many campgrounds contain fire rings, picnic tables, cleared areas for tents, campers, automobiles, and some recreational vehicles. Many of DNR’s campgrounds also have informational kiosks and toilet facilities.

Trail-based recreational use includes both motorized and non-motorized activities. Non-motorized uses include hiking and walking, trail running, horseback riding, hiking or riding with pack stock and/or pets, and mountain bicycle riding. Motorized uses include motorcycle riding, ATV riding, and 4x4 driving. DNR manages designated trails for specific recreational uses or combinations of uses. Trails can be exclusively non-motorized, primarily motorized, or mixed motorized and non-motorized. In addition to trails, forest roads provide considerable access for both developed and dispersed recreation activities. Many people recreate directly on forest roads or use these roads to access developed or dispersed recreation areas.

Dispersed recreational activities include, but are not limited to, hunting, fishing, target shooting, rock climbing, dispersed camping, water activities, hiking, forest product gathering, and geocaching. DNR encourages responsible public use of roads, trails, land, and water, consistent with its obligations as a trust and land manager. In some areas, dispersed use can become concentrated enough that non-designated trails and informal recreation areas are created. Recreational users sometime also venture off designated trails and roads and create trails without authorization from DNR. It is estimated there are hundreds of miles of non-designated trails on DNR-managed lands, and the department may not be aware of all the locations. Non-designated trails are not managed by the department and can cause conflicts with land management and environmental responsibilities.

Recreation planning

> **Text Box 3.7.2**
>
> **Is marbled murrelet habitat a current consideration in recreation planning?**
>
> Yes. Marbled murrelet habitat is part of the recreation suitability analysis done at the beginning of a recreation planning process.

DNR uses a recreation planning process when assessing a landscape (a defined block of DNR-managed land) for recreational use and public access. Formal recreation planning is an in-depth, multi-year process that considers many factors including, but not limited to, land management responsibilities, public and stakeholder input, adjacent landowners and land uses, and environmental responsibilities.

A critical step in formal recreation planning is the *recreation suitability assessment* for the landscape. This is a process where scientists, lands managers, planners, and GIS analysts identify criteria, gather data, and map areas that have long-term limiting factors for recreational use. Criteria are grouped into three categories: biological, geological/soils, and management. Maps are created to reflect areas with moderate to no suitability for recreational development. For recreation landscapes in the analysis area, marbled murrelet habitat has been identified as an important biological criterion in the recreation suitability maps. Three landscapes in the west-side planning units have undergone formal recreation planning: Reiter Foothills Forest, Snoqualmie Corridor, and Green Mountain and Tahuya State Forests.

Current projects and planning

BAKER TO BELLINGHAM RECREATION PLANNING

In autumn 2015, DNR launched a formal recreation planning process for approximately 86,000 acres of DNR-managed lands in Whatcom County. This planning process will include a full recreation suitability analysis, including marbled murrelet conservation strategies identified in the six alternatives.

DARRINGTON TO NORTH MOUNTAIN TRAIL DEVELOPMENT

Beginning in 2016, DNR is developing a new landscape for non-motorized recreation in the North Puget planning unit. To ensure compliance with the interim marbled murrelet strategy, the area will be field assessed by a trained biologist to identify suitable habitat and evaluate impacts and restrictions prior to the development of the trails.

Existing policies and regulations

Recreation on DNR-managed lands is guided by a variety of statutes, regulations, rules, county ordinances, and internal policies. RCW 79.10 directs the department to apply a "multiple use concept" to public lands "where such a concept is in the best interests of the state and the general welfare of the citizens thereof, and is consistent with the applicable provisions of the various lands involved."[20] Public access and recreation on DNR-managed lands are regulated under WAC Chapter 332-52. Trails built

[20] RCW 79.10.100

without department permission and that are not recognized by the department as part of a formal recreational trail system are referred to in this analysis as non-designated trails, consistent with DNR's *Recreational Trails Policy*. Several other department policies and plans guide recreation and public access on DNR-managed lands. These include, but are not limited to, the *Policy for Sustainable Forests*, the *South Puget HCP Planning Unit Forest Land Plan*, the *Policy on Public Use on DNR-Managed Trust Lands*, and adopted recreation plans for eight landscapes.

Development and maintenance of recreational facilities, trails, and trail bridges are also subject to applicable county ordinance and permit requirements, which vary from county to county. Recreational development and maintenance actions may also be subject to review under the State Environmental Policy Act (SEPA), RCW Chapter 43.21c, and WAC Chapter 197.11, depending on the scope of the project.

Recreation under the interim strategy

Under the interim marbled murrelet strategy, DNR follows specific practices related to recreational development to achieve marbled murrelet conservation objectives.

STRAITS, COLUMBIA, SOUTH COAST PLANNING UNITS

No new recreational development is permitted within occupied sites and buffers. Some additional areas are also deferred from harvest but are not known to contain occupied sites. Within these areas, recreation planning is done on a site-specific basis, depending on potential environmental impacts.

OESF, NORTH PUGET, AND SOUTH PUGET PLANNING UNITS

Marbled murrelet audio/visual surveys are incomplete in these areas. For known occupied sites, buffers, and unsurveyed old forest in the OESF planning unit, no new recreational development is permitted. For all other forested areas, a site-specific assessment is conducted for new recreation development proposals. The assessment looks for suitable habitat in the area where recreational development is being proposed. The type of recreation and any tree harvest would be evaluated against a quality rating of the area, and decisions are made on a site-specific basis.

3.8 Forest Roads

This section describes the use and management of DNR forest roads within the analysis area and how environmental impacts from forest roads are addressed by current regulations and policies.

Why are forest roads important?

Timber harvest operations, land management, and recreation all have a high dependency on the forest road system maintained by DNR. Construction and management of forest roads affect many natural resources, including wildlife, soils, and water. While the proposed alternatives do not amend the regulations and procedures already in place to minimize these impacts, they do propose some changes to the location and management of forest roads. Understanding the current rules related to road management is important to determine whether proposed changes might exacerbate environmental impacts or affect activities dependent upon forest roads.

Example of forest road on DNR-managed land. Photo: DNR

Current conditions

The risk of impact to natural resources from roads varies but is related to the location, quality of construction, density of roads, the number of stream crossings, noise disturbance from road use, construction, and maintenance activities. DNR implements rules, policies, and procedures (described in the next section) to minimize these impacts.

Road miles in the analysis area

DNR currently has 8,306 miles of active roads in the six west-side HCP planning units. In the analysis area, 63 percent (251 of 401) of the marbled murrelet occupied sites identified under the interim strategy (Alternative A) contain roads within the occupied site and/or the buffer. These roads include 793 miles of active, drivable road; 20 miles of active, decommissioned roads; 10 miles of orphaned roads; and 26 miles with unknown status but are most likely active.

Text Box 3.8.1

How many roads are currently located in occupied sites?

In the analysis area, 63 percent of occupied sites identified under the interim strategy contain roads within the occupied site and/or the buffer.

(Abandoned roads are not included in this count.) These road locations vary from the edge of the occupied site buffer to bisecting the occupied site.[21]

DNR conducts a variety of road work (construction, reconstruction, and maintenance activities) throughout the analysis area. "Construction" involves building new roads as well as major upgrade or widening of an existing road to accommodate a new use or standard. "Reconstruction" means reopening a decommissioned road, rebuilding failed road segments, or significantly reshaping the surface of the road. Typically, reconstruction takes place within the existing road prism. "Maintenance" involves new surfacing, grading, brushing, replacing existing culverts, and similar activities.

Example of recently abandoned DNR forest road. Photo: DNR

From 2003 to 2014, the miles of active road increased from 7,628 miles to 8,306 miles; however, the majority of this increase is due to a better road inventory and the acquisition of new property. Over the same 12-year period, DNR constructed 109 miles and abandoned 110 miles per year (on average), keeping the actual growth of the forest roads system due to new construction to a minimum (refer to Table 3.8.1).

Since 2011, new road construction mileage has dropped to an average of 88 miles per year, while road abandonment has increased to 117 miles per year; refer to Table 3.8.2. Future road management numbers are expected to match these current mileages, with abandonment decreasing to match or be slightly higher than the new construction numbers. The decrease in planned abandonment is due to the upcoming completion of the *Road Maintenance and Abandonment Plans* required under WAC 222-24-050. However, abandonment will still be an important management option under the action alternatives.

[21] DNR designates forest roads as active, abandoned, or orphaned roads. *Active roads* are currently used for timber management or are *decommissioned*, meaning that they are closed for current use but are needed for long-term management so they can be re-opened in the future. *Abandoned roads* are physically closed to all current and future uses, and natural resources have been restored within the road prism. *Orphaned roads* are roads or railroad grades that have not been used for forest practices activities since 1974 and have not been abandoned (WAC 222-24-052 (4)). Orphaned roads are available for use and can become active roads when used again for forest practices.

Table 3.8.1. Average Miles of Annual Road Work From 2003 to 2014, by Planning Unit

Type of road work (miles)	Columbia	North Puget	OESF	South Coast	South Puget	Straits	All Units
New construction	21	43	4	21	10	10	109
Reconstruction	16	96	2	10	4	4	132
Decommissioning	4	8	6	5	2	4	28
Abandonment	18	70	1	9	9	3	110

Table 3.8.2. Average Miles of Annual Road Work From 2011 to 2014, by Planning Unit

Type of road work (miles)	Columbia	North Puget	OESF	South Coast	South Puget	Straits	All Units
New construction	18	35	3	16	9	7	88
Reconstruction	8	96	2	3	4	3	115
Decommissioning	0	0	7	2	1	1	11
Abandonment	15	77	0	8	13	3	117

ROCK PITS

Rock pits are closely associated with roads. Aggregate is an important, non-renewable resource within the landscape. Forest roads continually lose rock from the road surface from many causes such as log truck haul, recreational traffic, and revegetation. More rock sources will need to be developed to meet the future road construction and maintenance needs of the forest road system. As older rock sources are depleted, they are reclaimed (abandoned) similarly to roads. There are currently six rock pits located within the occupied sites designated under Alternative A, with another 27 located within 0.25 miles of an occupied site. Frequency of use of these rock pits varies widely depending on road work needs. Some are used annually or multiple times per year, while others may only be used once every 1 to 5 years.

How roads impact the environment

Roads provide access to forest resources for timber harvest and management, collection of non-timber forest products, research, and a variety of recreational uses. Forest roads are also a source of environmental impacts, including habitat disturbance, disruption of natural water flow paths, potential for mass wasting, and erosion affecting water quality.

HABITAT DISTURBANCE

Roads can disturb habitat for wildlife by creating edges that disrupt blocks of continuous forested habitat needed by many wildlife species (refer to Section 3.5 and Appendix H, Potential Impacts and Mitigation focus paper). Roads also provide corridors for predators such as jays and ravens, which prey on marbled murrelet eggs and chicks. Recreational use of forest roads can also lead to increased amounts of garbage that also attracts predators of marbled murrelets.

Noise

Road construction and maintenance activities include blasting and use of heavy equipment that have noise-disturbing impacts on marbled murrelets. Blasting is used for road construction, rock production, and expansion and development of new rock pits. Use of roads by heavy hauling trucks, as well as by off-road vehicles, trucks, and other vehicles can also cause noise-related disturbance impacts (refer to Section 4.6).

Road work is largely conducted during the summer construction season, which aligns with the marbled murrelet nesting season. Under the interim strategy, noise-producing activities such as blasting, pile-driving, rock crushing, and using heavy equipment in or within one-quarter mile of occupied sites must follow daily timing restrictions to avoid coinciding with marbled murrelets visiting their nests. Timing restrictions are also applied to activities in other types of habitat (refer to sections that follow).

Stream crossings

Stream crossings (predominately culverts) can create barriers to fish passage by increasing water velocities, creating large vertical drops, and containing inadequate water depths. There are currently 212 culverts and 39 bridges located within occupied sites and buffers designated under Alternative A. All of these stream crossings require maintenance during their lifespan and require replacement when found to be functionally or structurally deficient (undersized or failing). Culvert lifespan varies by material, location, exposure to saltwater or acidic soils, and abrasion rates. Previous galvanized metal culverts have lasted 20 to 40 years before needing replacement. Newer aluminized coated culverts are expected to last 40 to 60 years.

Historically, DNR averages 87 fish barrier replacements or removals each year. Removals of fish barriers are expected to decrease in the analysis area beyond 2016, except in OESF where the decrease is expected after 2021. The number of replacements of non-fish stream crossings is not known at this time but is expected to be slightly higher than the fish barrier replacement numbers. New stream crossings will be needed with new road construction and during reconstruction of decommissioned roads. The number of new stream crossings is unknown because it is determined on a case-by-case basis along with road location.

DISRUPTION OF WATER FLOW PATHS

Road construction can cause the disruption of the natural flow patterns of groundwater and surface water. A road cut into a hillside can intercept subsurface water, bringing it to the surface and causing it to flow down a ditch or road surface. Inadequate drainage can interrupt the hydrologic connectivity of surface water and cause concentration of flows or move water from one drainage to another (pirating).

Concentrating flows increases the energy carried by the water and can cause erosion, puddles, or ground saturation that can lead to sediment delivery, maintenance problems, or mass wasting events. Pirating water moves water from one basin to another, changing the natural amount of water each drainage is prepared to carry. This can cause changes in the size and shape of the channel, decreased water availability for fish, and changes in vegetation type. Managing drainage structures so the road does not carry water for long distances eliminates pirating water and reduces the amount of water (energy) carried by ditches to erodible soils, surface water, or other protected infrastructure.

Inadequately sized culverts in non-fish bearing streams cause an imbalance in the channel, creating deposits of sediment upstream and scouring streambed material downstream. They also increase the chance of culvert blockages and flooding across the road. Flooding at culverts can lead to a distinct failure of the road at the culvert site or a long failure along the road or ditch line. Replacing undersized culverts with larger structures vastly reduces the risk of these types of failures.

MASS WASTING

Poor location, quality of construction, and management of water can lead to road-caused mass wasting events (such as small slumps or large landslides). Roads built on unstable slopes or landforms can increase the potential for landslides, threatening natural resources and/or public safety. Road-caused mass wasting events are typically shallow but can still produce large quantities of sediment and damage to the road system as well. Well-planned road locations and active management of water can reduce the risk of road-caused mass wasting.

EROSION AND WATER QUALITY

Fine sediments from native surface or aggregate surface roads can enter surface waters, increasing turbidity and lowering water quality. Erosion caused by traffic creates sediment particles that are washed from the roads by rain and captured by ground or surface water or are lifted into the air by passing vehicles. Sediments are also created during construction and maintenance activities. These activities remove vegetation, exposing bare soil, and loosen compacted earth, making the particles easier to transport. Adequate and well-placed drainage structures, good vegetation cover, lower traffic rates, and quality aggregate surfaces all help to reduce erosion and delivery of sediment to water.

Existing policies and regulations

The Forest Practices Act (RCW 76.09 and WAC 222-24 concerning Road Construction and Maintenance) and the 1997 HCP road management strategies are the primary regulations that govern road work. In addition, internal policies and guidance on road work include the *Policy for Sustainable Forests*, watershed analysis plans, and the DNR *Forest Roads Guidebook*. Typical road construction and hydraulic projects are considered Class I–III forest practice and are exempt from the State Environmental Policy Act (SEPA) by RWC 43.21C.037(1). SEPA is required for road work in conjunction with a timber sale or other non-exempt project to eliminate the segmentation of environmental effects and may be used for stand-alone projects depending on the scope of work. For individual projects, SEPA may be needed if the project has the potential to affect public resources or use. SEPA is used to determine if there are environmental impacts, if specific impacts can be mitigated, or if significant environmental impacts are likely to occur, requiring more analysis or a change of plans.

1997 HCP road management under the interim strategy (no action alternative)

The 1997 HCP road management strategies guide DNR to reduce the amount of new roads, control the overall size of the road network, design, plan, construct, and abandon roads to avoid impacts to habitat areas of federally listed and certain unlisted species and protect riparian areas.

Management is similar across the analysis area, but because the process for identifying marbled murrelet habitat currently differs among the planning units, different management approaches apply in different types of marbled murrelet habitat under the no action alternative (refer to Table 3.8.3).

Table 3.8.3. Summary of Road Management in Marbled Murrelet Habitat Under the No Action Alternative (Alternative A, Interim Strategy)

Habitat type	Road construction	Reconstruction, abandonment, and maintenance	Noise-creating activities related to road work
Occupied sites	Prohibited	OESF: subject to review if felling trees over 6” in diameter[a]	Timing restrictions evaluated or required within a one-quarter mile of occupied sites
Old forest habitat (OESF)	Subject to review	Subject to review if felling trees over 6” in diameter	Timing restrictions evaluated within a one-quarter mile of unsurveyed old forest habitat
Reclassified habitat	Subject to review	OESF: subject to review if felling trees over 6” in diameter	n/a
North and South Puget field-delineated, newly-identified habitat[b]	Operational access is prohibited in higher-quality habitat; some access may be allowed in low-quality habitat if surveys determine no occupancy, unless within a one-quarter mile of occupied site	Operational activities must minimize the loss of platform trees, especially those containing four or more platforms. Consultation with USFWS is required.	Timing restrictions on the use of heavy equipment

[a] OESF interim strategies letter dated March 7, 2013.
[b] 2007 and 2009 concurrence letters.

To avoid impacts or potential impacts to marbled murrelet habitat, longer roads are sometimes built and in areas that may be less desirable for road construction. This has included building mid-slope roads, locating roads with more stream crossings, and choosing more restrictive hauling routes. Avoiding occupied sites, buffers, and reclassified habitat can put pressure on other lands by causing higher road use (more hauling) and haul-related maintenance on existing roads in those areas.

The interim strategy is challenging to implement for road activities in the North and South Puget HCP units. Survey work to identify occupied sites and buffers are incomplete in these areas; therefore, site-specific assessments of habitat are needed to build roads. This sometimes leads to delay in road management or road-building decisions and delay the timing of timber harvest or timber sales.

3.9 Public Services and Utilities

This section describes the current location and management of public services and utilities within the analysis area.

Why are public services and utilities important?

A technician repairs microwave dishes on a communication tower located on state trust lands (Grass Mountain, South Puget planning unit). Photo: Steve Diamond/NorthWest Tower Engineering, Inc.

Non-timber revenue sources—such as selling rights-of-way and leases for communications and energy-related uses—are a critical component of DNR's business strategy (DNR 2006, p 26). In addition to providing revenues for state trust beneficiaries, these uses are important to the communications and energy infrastructure of the entire Puget Sound region.

The following sections describe existing rights-of-way and leases for communications and energy-related uses that may be affected by the alternatives. For this assessment, these uses include the following:

- Utility rights-of-way for transmission lines.
- Communications sites (for example, cell and radio towers).
- Oil and gas production.

Current conditions

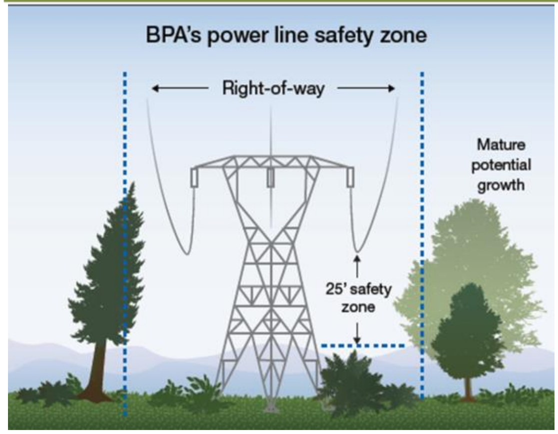
Utility rights-of-way

Dozens of telephone companies, public utilities districts, and power providers, including Puget Sound Power and Light, Pacific Power, Seattle City Light and Tacoma Public Utilities, and the federal Bonneville Power Administration (BPA), maintain utility rights-of-way through DNR-managed lands in the analysis area.

Rights-of-way for major utility corridors may be up to 300-feet wide for areas where multiple lines share a single corridor.

Maintenance of telephone and electric transmission lines requires access roads, many of which occur outside the transmission line rights-of-way. A typical access road right-of-way is 50-feet wide. Inspection, maintenance, and repairs of utility lines may involve occasional use of helicopters. Maintenance crews may also remove trees outside of the right-of-way to prevent trees from falling onto transmission lines or structures. All transmission lines also eventually require replacement, tower upgrades, or expansion.

Text Box 3.9.1



BPA 2008

How are transmission lines managed?

BPA typically maintains a 150-foot-wide cleared right-of-way easement for 500-kV transmission lines under its Vegetation Management Program (BPA 2000 and 2015).

Leases for communications and energy-related facilities

Communication facilities include antennas and associated small buildings or sheds for commercial television and radio, 2-way VHF radio, cellular, and wireless broadband. DNR manages more than 100 communication sites across Washington, including several key sites in the analysis area. Communication sites are typically located on non-forested hilltops and mountaintops within range of populated areas and highway corridors.

Table 3.9.1 contains descriptions of these uses as well as known and potential future locations trends within the analysis area.

Table 3.9.1. Communication and Energy-Related Infrastructure on HCP Lands

Leases/contracts	General locations within analysis area	Description	Trends
Communication sites	Found in multiple locations, primarily on high peaks, including: • Devil's Mountain (North Puget planning unit) • Grass and Tiger Mountains (South Puget planning unit) • Radar Ridge and Capitol Peak	Typically high-elevation sites with multiple towers, antennas, and other structures and outbuildings. Usually less than an acre. Include DNR-provided or lessee-constructed access roads.	Based on recent annual DNR reports, demand for and placement of communication sites on DNR state trust lands is increasing.
Oil and gas leases	No oil or gas is currently produced on DNR HCP lands, though potential oil and gas resources are located in the North and South Puget planning units. Pipeline corridors do run through some DNR-managed lands.	DNR may sell rights to explore for, drill, extract, or remove underground deposits of oil and gas (i.e., petroleum and natural gas). Site size varies, but most are only a few acres.	DNR anticipates new leases to be granted in the next decade. [a]

[a] 2015 State Trust Lands HCP 2014 Annual Report (DNR 2015b)

Existing policies and regulations

Policy for Sustainable Forests

The 2006 *Policy for Sustainable Forests* clearly identifies that selling rights-of-way and leases for communications and energy-related uses are a critical component of DNR's business strategy (DNR 2006, p. 26). It also recognizes that public or private utilities may need to cross state trust lands and directs DNR to cooperate with requests by granting permanent and temporary rights-of-way consistent with applicable policies and regulations, including SEPA, *Forest Practice Rules*, the 1997 HCP (including the riparian strategies), the sustainable harvest calculation, and other state and federal laws (refer to Chapter 1).

The 1997 HCP

Leases, contracts, permits, and easements granted by DNR for communications and energy-related facilities are subject to the conditions of their contracts and the 1997 HCP. DNR reviews proposed uses to ensure compliance with the commitments of the 1997 HCP. These commitments are included in the HCP such that activities will not increase the level of take beyond a *de minimis* level. The 1997 HCP defines what levels of activity are *de minimis* and how the activity is otherwise covered by the HCP (DNR 1997, Ch. IV, Section H).[22]

ESA compliance for any additional take of marbled murrelets (or take of any other listed species) beyond a *de minimis* level for non-timber resources would need to be addressed as a separate action, with formal consultation between DNR and USFWS. This could potentially initiate further NEPA and SEPA review.

Federal agencies consult with DNR on projects that may cross state lands. For example, as part of project review under NEPA, BPA may identify and mitigate potential conflicts with DNR land use plans, including the 1997 HCP.

[22] The level of impact from these activities is reviewed during the annual meetings described in the Implementation Agreement §16.2b; also refer to §17.0 for easements that are accomplished through a land transfer, sale, or exchange (DNR 1997, p. B.4-6).

3.10 Environmental Justice

This section describes where minority and low-income populations are located within the analysis area and the degree to which those populations use and depend upon DNR-managed forestlands.

Why is environmental justice important?

The term "environmental justice" addresses Executive Order 12898, which directs federal agencies to identify and address any "disproportionately high and adverse effects" of their actions, programs, or policies on low-income and minority populations (CEQ 1997).

Environmental justice concerns considered in this DEIS are focused on whether any of the alternatives may cause disproportionately high adverse economic effects on minority or low-income populations due to reduced timber harvest and other forest management activities, particularly where these populations are dependent on timber revenues and forest-related jobs.

Potential economic effects on American Indians are also considered.[23] Issues related to traditional tribal access and cultural uses of state lands are addressed separately under Sections 3.12 and 4.12, Cultural Resources.

Text Box 3.10.1

Cedar block cutting. Photo: UW 2016

Who relies on the forest?

Many Hispanic communities within the analysis area are economically tied to private, state, and federal forests. Hispanic forest workers now make up a large proportion of the workforce when it comes to some of the most difficult (and often lowest-paying) forest-related jobs, including tree planting, thinning, and harvesting and collection of both timber and non-timber products such as western floral greens. Shown in photo: Cedar block cutting.

Current conditions

Minority forest workforce

The forest workforce, like the forest industry itself, has changed and will likely continue to do so. Shifting from the primarily local, white workforce that harvested trees during the high harvest years of the second half of the last century, the workforce is now made up to a large degree by immigrant workers, primarily Hispanic. This trend of increasing populations of minority forestry workers in rural communities began as early as the 1970s and continues today.

Hispanic forest workers now make up a large proportion of the workforce when it comes to some of the most difficult (and often lowest-paying) forest-related jobs, including tree planting, thinning, and

[23] The term American Indian is used in this section based on U.S. Census Bureau race classifications.

harvesting of both timber and non-timber forest products including mushrooms, salal, bear grass, and other western greens (Ballard 2004, Campe and others 2008).

Due to this trend in forest workers, many Hispanic communities within the analysis area are economically tied to private, state, and federal forests. Other work crews are part of a seasonal workforce that travels around the western U.S. following seasonal peaks in labor markets.

Minority and low-income populations

For this assessment, minorities are considered within the following U.S. census tracking data racial and ethnicity categories:

- Black or African American
- American Indian and Alaska native
- Asian
- Native Hawaiian and other Pacific Islander
- Hispanic
- Two or more races

Minority and low-income populations are listed in Table 3.10.1 by county. [24] Acres of DNR-managed land within the county are provided for context.

Table 3.10.1. Minority and Low-Income Populations, by County, With Acres of DNR-Managed Land

County	Minority population (% of county population)	Low-income population (% of county population)	Acres of DNR-managed lands
Clallam	18.3	16.2	162,041
Cowlitz	17	20.6	28,270
Grays Harbor	22.5	19.6	90,603
Island	21.5	10.3	340
Jefferson	12.4	14.1	203,774
King	40.2	11.3	116,880
Kitsap	24.4	11.2	14,235
Kittitas	17.1	18.6	2,591
Lewis	17.4	17.1	96,317
Mason	21	15.6	58,925

[24] The environmental justice guidelines developed by CEQ 1997 and EPA 1998 indicate that low-income populations should be identified based on the annual statistical poverty thresholds established by the U.S. Census Bureau. The U.S. Census Bureau defines a poverty area as a census tract or other area where at least 20 percent of residents are below the poverty level (U.S. Census Bureau 2013). Median household income and per capita income are other measures that can be used to identify low-income environmental justice populations.

County	Minority population (% of county population)	Low-income population (% of county population)	Acres of DNR-managed lands
Pacific	19.5	17.8	86,898
Pierce	34.7	13.1	24,959
San Juan	11.8	12.7	1,193
Skagit	27.3	15.7	139,540
Snohomish	30.2	9.9	157,225
Thurston	26.2	11.9	64,588
Wahkiakum	10.9	13.9	40,195
Whatcom	22.1	15.7	88,903
Total (Average)	32.1	13.2	1,377,477

Source: U.S. Census 2015

Existing policies and regulations

Executive Order 12898 requires federal agencies to take appropriate steps to identify and avoid disproportionately high and adverse effects of federal actions on the health and surrounding environment of minority and low-income persons and populations. All federal programs, policies, and activities that substantially affect human health or the environment shall be conducted to ensure that the action does not exclude persons or populations from participation in, deny persons or populations the benefits of, or subject persons or populations to discrimination under such actions because of their race, color, income level, or national origin. The Executive Order was also intended to provide minority and low-income communities with access to public information and public participation in matters relating to human health and the environment.

3.11 Socioeconomics

This section describes the economic conditions that may result from current management practices on state trust lands. Impacts of the alternatives on these conditions will be discussed in Section 4.11.

Why are socioeconomics important?

DNR-managed forestland plays an important role in the local economies of 18 counties in the analysis area. Changes to how much land is available to harvest or use for other ecosystem services can impact these local economies. Maintaining funding to state trusts is an important piece of the need, purpose, and objectives for the long-term conservation strategy.

The affected environment for this section is all trusts and counties with state trust lands inside the marbled murrelet analysis area (Table 3.11.1). Counties that do not contain trust lands within the analysis area are not part of the affected environment. State trust lands are defined in Chapter 1.

Table 3.11.1. Acres of Trust Lands by Management Category in Counties Within the Analysis Area (counties containing state trust lands only)

County	DNR-managed lands in analysis area: Acres	No harvest allowed: Acres (%)	Harvest is constrained: Acres (%)	Available for harvest: Acres (%)	DNR-managed lands outside the analysis area: Acres
Clallam	162,041	44,425 (27%)	75,984 (47%)	41,632 (26%)	0
Cowlitz	28,270	9,188 (11%)	46,144 (53%)	31,118 (36%)	58,229
Grays Harbor	90,603	23,680 (26%)	18,999 (21%)	47,924 (53%)	0
Island	340	340 (100%)	0 (0%)	0 (0%)	0
Jefferson	203,774	86,380 (42%)	101,047 (50%)	16,346 (8%)	0
King	116,880	53,536 (46%)	41,339 (35%)	22,005 (19%)	0
Kitsap	14,235	4,944 (35%)	3,908 (27%)	5,383 (38%)	0
Kittitas[a]	2,591	74,517 (36%)	120,598 (58%)	12,905 (6%)	208,403
Lewis	96,317	15,415 (16%)	47,828 (49%)	33,647 (35%)	0
Mason	58,925	10,148 (17%)	13,563 (23%)	35,214 (60%)	0
Pacific	86,898	30,488 (35%)	19,615 (23%)	36,795 (42%)	0
Pierce	24,959	2,971 (12%)	20,593 (83%)	1,495 (6%)	0
San Juan	1,193	1,193 (100%)	0 (0%)	0 (0%)	0
Skagit	139,540	49,469 (35%)	51,156 (37%)	38,916 (28%)	0
Snohomish	157,225	65,740 (42%)	40,891 (26%)	50,593 (32%)	0
Thurston	64,588	9,762 (15%)	15,457 (24%)	39,370 (61%)	0
Wahkiakum	40,195	12,201 (30%)	10,954 (27%)	17,040 (42%)	0
Whatcom	88,903	37,384 (42%)	25,926 (29%)	25,595 (29%)	0
Total	1,377,477	497,176 (32%)	604,188 (38%)	469,392 (30%)	1,746,244

[a] DNR-managed lands in Kittitas County are not subject to the interim strategy for marbled murrelet in the 1997 HCP. A small portion of this county is included within the inland range of the marbled murrelet and is listed here for context, but impacts will not be evaluated in this DEIS because the long-term strategy will not apply to this county.

Current conditions

Population

The total human population in affected counties in the marbled murrelet analysis area as of 2015 is about 5 million (OFM 2016a; Table 3.11.2).

Economic diversification and timber dependency

Daniels 2004 assessed the economic diversity[25] and socioeconomic resiliency[26] of Washington counties. Most counties in the analysis area were found to have medium or high socioeconomic resiliency and be among the counties with greater economic diversity in the state. There were notable exceptions, however. Wahkiakum County is one of the least socioeconomically resilient and least economically diverse county in the state (refer to Table 3.11.2). Pacific County also has low socioeconomic resiliency and below-median economic diversity. All counties in the analysis area are classed as having medium or high forest dependence.[27] Daniels 2004 identified Pacific and Wahkiakum counties as "DNR counties of concern" due to the relatively large role DNR-managed lands have in the socioeconomic well-being of these counties. Daniels states that these counties "may experience difficulty adapting to changes in DNR forest management strategies."

Text Box 3.11.1

How resilient are local economies to changes in DNR forest management?

While most counties in the analysis area have medium to high socioeconomic resiliency, Pacific and Wahkiakum counties are highly dependent on DNR-managed lands and "may experience difficulty adapting to changes in forest management strategies." (Daniels 2004)

Since the Daniels study was done in 2004, the economies of Pacific and Wahkiakum counties have not changed markedly. The Washington State Employment Security Department 2016 states that employment fell in Pacific County from 2006 to 2012 and has since recovered slowly. The primarily industries in the county were natural resource-based including shellfish farming, forest-products, and other farming. The only sectors with an increase in employment were the information and finance sectors, but these sectors were relatively small in Pacific County. The population of Pacific County has declined since 2000 (Pacific County 2014). For Wahkiakum County, the Washington State Employment Security Department 2016 states that logging is the main industry in the county, and local government is the main source of jobs and wages. Total employment in the county has declined since the 1990s. Most of this decline has been from the loss of service jobs.

[25] Economic diversity is measured by Daniels 2004 using an index of regional specialization.
[26] Socioeconomic resiliency is defined by Daniels 2004 as the ability to adapt to change. Daniels assumes that communities with high social and economic diversity are more resilient.
[27] Forest dependence is determined by Daniels 2004 based on the forest area in each county.

Table 3.11.2. Socioeconomic Resiliency and Economic Diversity Rating (Modified From Daniels 2004)

County	Socioeconomic resiliency	Economic diversity 4 = high diversity	Population, 2015 (OFM 2016a)	Employment, 2014 (OFM 2016a)
Clallam	Medium	3	72,650	22,035
Cowlitz	High	4	104,280	36,910
Grays Harbor	Medium	3	73,110	21,769
Island	High	3	80,600	15,200
Jefferson	Medium	3	30,880	7,920
King	High	4	2,052,800	1,237,660
Kitsap	High	4	258,200	82,400
Kittitas	Medium	2	42,670	13,909
Lewis	Medium	3	76,660	23,590
Mason	Medium	2	62,200	13,900
Pacific	Low	2	21,210	6,195
Pierce	High	4	830,120	277,863
San Juan	Medium	2	16,180	5,445
Skagit	High	4	120,620	48,291
Snohomish	High	4	757,600	267,792
Thurston	High	4	267,410	103,100
Wahkiakum	Low	1	3,980	729
Whatcom	High	4	209,790	83,691
Total	N/A	N/A	5,080,960	

Trust revenue

State trust lands provide revenue for trust beneficiaries (refer to Chapter 1). Timber sales are the single largest source of revenue. However, other revenue sources exist, including leasing of lands for communication sites and special forest products,[28] interest income, permits, fees, and miscellaneous sales and other revenue.[29]

From 2011 to 2015, an annual average of about $175 million (2015 dollars; U.S. Bureau of Labor Statistics 2016) was distributed to trust beneficiaries that receive revenue from lands within the analysis area (Tables 3.11.3 and 3.11.4). Some of these beneficiaries also received revenue from lands outside of the analysis area (Tables 3.11.3 and 3.11.4). Total distributions vary due to fluctuations in timber and agricultural markets. The Common School and Escheat Trust received distributions from land transactions under the Trust Land Transfer Program. Funding for this program varies from year to year. (Refer to DNR 2013 for more information about the Trust Land Transfer Program).

Distributions from most major sources have been relatively stable over the 2011 to 2015 period. The exception is funds for the Trust Land Transfer Program, which have decreased over the period. Timber sales generated an average of $114.5 million per year. Other important sources of trust revenue are agricultural and commercial leases and fund transfers through the Trust Land Transfer Program. From 2011 to 2015, the trust land transfer program provided an average of $32.7 million (2015 dollars) per

[28] Such as brush and boughs.
[29] Other lease categories include agriculture, mineral and hydrocarbon, special use, commercial real estate, and right-of-way.

year, all to the Common School Trust. Leases allowing harvest of non-timber forest products from trust lands generated about $500,000 or less per year in revenue. Refer to DNR Annual Reports for more detail on trust revenues and distributions. The revenue generated from sales and leases varied based on market conditions and qualities sold.

Table 3.11.3. Average Annual Fund Distribution to Beneficiaries of the Federally Granted Trusts for Fiscal Years 2011–2015 in 2015 Real Dollars (Revenue from lands statewide)

Trust(s)	Distributions from timber sales and timber sale related activities	Distributions from all other revenue sources	Total distributions
Agricultural School Grant	$3,655,419	$417,510	$4,072,930
Capitol Building Grant	$6,704,014	$146,399	$6,850,413
CEP&RI and CEP&RI transferred[a]	$4,407,988	$928,689	$5,336,677
Common School and Escheat	$35,168,373	$56,391,303	$91,559,676
Normal School	$2,304,357	$158,619	$2,462,976
Scientific School Grant	$6,339,614	$1,219,878	$7,559,493
University Grant (original and transferred)	$1,863,713	$270,382	$2,134,095
Total	$60,443,478	$59,532,781	$119,976,259

[a] CEP&RI refers to charitable, educational, penal, and reformatory institutions as defined by the state.

Table 3.11.4. Average Annual Distribution of Funds to Beneficiaries of State Forest Trust Lands (State Forest Transfer and State Forest Purchase Trusts) for Fiscal Years 2011–2015, in 2015 Dollars[30]

Beneficiary county*	Distributions from timber sales and timber sale related activities	Distributions from all other revenue sources	Total distributions
Clallam	$5,872,468	$318,449	$6,190,916
Cowlitz	$2,112,276	$26,159	$2,138,435
Grays Harbor	$1,543,343	$2,930	$1,546,273
Jefferson	$1,693,830	$27,912	$1,721,743
King	$1,872,807	$73,671	$1,946,478
Kitsap	$380,168	$67,450	$447,618
Lewis	$7,042,221	$8,016	$7,050,237
Mason	$3,312,323	$160,334	$3,472,657
Pacific	$1,893,294	$11,719	$1,905,012
Pierce	$391,641	$1,732	$393,373
Skagit	$9,498,820	$55,382	$9,554,201
Snohomish	$10,309,824	$161,050	$10,470,874
Thurston	$3,340,066	$133,284	$3,473,350
Wahkiakum	$1,610,234	$2,073	$1,612,307
Whatcom	$3,322,456	$68,600	$3,391,056
Total	$54,195,769	$1,118,761	$55,314,530

* No State Forest Lands are present in Island or San Juan counties.

[30] Includes only counties that benefit from lands within then analysis area. Several counties in the analysis area do not contain State Forest Trust lands and several counties contain State Forest Trust lands outside the analysis area. Does not include an average of $8,600 of interest distributed to state forestland beneficiaries.

Trust acreage and management options

Trust lands are distributed throughout the state. Federal trusts are located both inside and outside the marbled murrelet analysis area. State Forest lands are present in 15 of the counties that fall within the analysis area (Table 3.11.5). For all counties except Cowlitz County, all the State Forest lands fall within the analysis area (Table 3.11.6).

Trust lands are organized into land classes that define areas with different management constraints. Lands may be deferred or constrained from harvest to meet objectives defined by the HCP, *Policy for Sustainable Forests*, or state or federal laws. Examples of these constraints include northern spotted owl conservation, unique habitats, lands in stream and wetland buffers, and associated unstable slopes. In most cases, only thinning harvest can occur on lands in riparian areas.

Table 3.11.5. Statewide Management Options by Trust or Trust Group under the No Action Alternative (Acres where harvest is limited includes both the uplands with specific objectives and the riparian land classes)

	Trust(s)	No harvest allowed Acres (%)	Harvest is constrained Acres (%)	Available for harvest (includes non-forested lands) Acres (%)	Total trust area Acres (% of acres in the analysis area)
Federally granted trusts	Agricultural School Grant	1,684 (19%)	15,612 (22%)	41,800 (59%)	71,110 (35%)
	Capitol Building Grant	28,504 (26%)	44,762 (41%)	36,294 (33%)	109,563 (73%)
	CEP&RI (including CEP&RI transferred) Grant	6,883 (10%)	12,734 (18%)	49,901 (72%)	69,518 (38%)
	Common School and Escheat	317,645 (18%)	369,527 (21%)	1,105,051 (62%)	1,792,224 (28%)
	Normal School	14,040 (21%)	23,815 (36%)	28,899 (43%)	66,754 (39%)
	Scientific School Grant	15,693 (19%)	32,050 (38%)	36,342 (43%)	84,084 (51%)
	University Grant (original and transferred)	15,136 (17%)	26,718 (30%)	47,209 (53%)	89,062 (50%)
Other lands	Community College Forest Reserve	72 (2%)	1,080 (31%)	2,340 (67%)	3,492 (100%)
	Community Forest Trust	49,782 (100%)	0	0 (0%)	49,782 (3%)
	Land Bank	0	0	364 (100%)	364 (>1%)
	Water Pollution Control Division Trust land	811 (14%)	1,520 (25%)	3,659 (61%)	5,990 (100%)
	Other	111,537 (91%)	3,508 (3%)	7,730 (6%)	122,776 (96%)

Table 3.11.6. Management Options on State Forest Lands (State Forest Transfer and State Forest Purchase Trusts) Within the Analysis Area, by County, for Alternative A

County	No harvest allowed Acres (%)	Harvest is constrained Acres (%	Available for harvest Acres (%)	Total trust area Acres (% of acres in the analysis area)
Clallam	24,305 (26%)	37,930 (41%)	31,072 (33%)	71,110 (100%)
Cowlitz	803 (7%)	4,164 (37%)	6,389 (56%)	11,355 (46%)
Grays Harbor	2,810 (9%)	8,123 (26%)	20,412 (65%)	31,345 (100%)
Jefferson	2,265 (15%)	1,935 (13%)	10,515 (71%)	14,716 (100%)
King	6,326 (28%)	11,273 (49%)	5,324 (23%)	22,923 (100%)
Kitsap	1,188 (16%)	2,996 (39%)	3,450 (45%)	7,633 (100%)
Lewis	8,293 (19%)	16,694 (39%)	18,074 (42%)	43,061 (100%)
Mason	4,743 (16%)	6,407 (22%)	17,764 (61%)	28,914 (100%)
Pacific	8,599 (37%)	4,844 (21%)	9,841 (42%)	23,284 (100%)
Pierce	1,306 (11%)	10,907 (89%)	8 (0%)	12,221 (100%)
Skagit	27,653 (33%)	27,111 (32%)	29,998 (35%)	84,762 (100%)
Snohomish	13,728 (21%)	20,435 (32%)	29,974 (47%)	64,137 (100%)
Thurston	5,527 (13%)	9,993 (23%)	28,044 (64%)	43,563 (100%)
Wahkiakum	4,072 (32%)	3,213 (28%)	5,504 (43%)	12,789 (100%)
Whatcom	9,946 (33%)	8,696 (29%)	11,601 (38%)	30,242 (100%)

Tax revenue

Timber harvests generate direct revenue for county governments and the state general fund through the forest tax and create economic activity that results in other state and local tax revenue (Washington Department of Revenue 2016a). From 2011 to 2014, an average of $26.0 million per year (in 2015 dollars) was distributed to counties within the analysis area from forest tax revenue (Table 3.11.7 Washington Department of Revenue 2016b). Average sales tax distributions were $400 million in the same period. Sales tax distributions exceed forest tax distributions in all counties in the analysis area except Pacific and Wahkiakum counties.

Looking broadly at taxes generated by harvest of timber and manufacture of wood products, Mason and Lippke 2007 reported that the state and local taxes generated per million board feet of annual timber production equaled $210,000 (in 2004 dollars, which equals $259,000 in 2015 dollars), not including the forest tax. The DNR harvested 5.038 billion board feet in western Washington in the 2005–2014 period. At this harvest volume, state and local taxes generated from state trust lands is about $130 million per year (2015 dollars).

Other activities, such as recreation and harvesting of non-timber forest products on state trust lands, also have the potential to generate tax revenue in counties within the analysis area. The extent to which they do is not known. A report by Briceno and Schundler 2015 looking at all ownerships estimated that outdoor recreation generates state and local tax contributions of about $2 billion per year (2015 dollars).

They estimated that recreation expenditures, excluding equipment, related to trust lands was $456 million per year (2015 dollars), while expenditures, excluding equipment, on all lands was $12.8 billion (2015 dollars). If the state and local tax contributions from state trust land recreation is proportional to the contribution of state trust land recreation to total expenditures, the state and local taxes generated by recreation on state trust lands is $73 million per year (2015 dollars).

Table 3.11.7. Average Sales Tax Distributed to Counties in the Analysis Area in 2011–2014, in 2015 Real Dollars (Washington Department of Revenue 2016b, 2016c)

County	Average annual sales tax distribution by county	Average annual forest tax distribution by county	Ratio of forest tax distribution to sales tax distribution[a]
Clallam	$7,814,019	$1,838,801	0.24
Cowlitz	$7,870,334	$2,697,259	0.34
Grays Harbor	$5,646,926	$3,440,238	0.61
Island	$7,155,632	$49,588	0.01
Jefferson	$4,164,881	$1,118,991	0.27
King	$142,725,487	$1,238,050	0.01
Kitsap	$28,232,022	$342,274	0.01
Kittitas	$6,052,652	$48,980	0.01
Lewis	$7,903,983	$4,558,113	0.58
Mason	$5,991,640	$1,341,302	0.22
Pacific[b]	$1,564,607	$2,598,692	1.66
Pierce	$64,077,495	$1,489,606	0.02
San Juan	$4,825,095	$6,534	0.00
Skagit	$15,093,817	$1,234,753	0.08
Snohomish	$53,844,884	$1,369,989	0.03
Thurston	$26,245,441	$1,069,567	0.04
Wahkiakum[b]	$332,772	$762,843	2.29
Whatcom	$24,188,002	$797,614	0.03
Total	$413,729,689	$26,003,193	0.06

[a] Ratio of forest tax distribution to sales tax distribution >1.0 indicates timber tax distribution exceeds sales tax distribution.
[b] Indicates counties where the forest tax distribution exceeds sales tax distribution.

Employment

Activities on trust lands provide direct and indirect employment in counties in the analysis area. Examples of direct employment include land management staff hired by DNR, timber harvest operators, and non-timber forest product harvesters. Examples of indirect employment include hauling and processing, equipment servicers, and sporting goods vendors.

Mason and Lippke 2007 found that the direct employment resulting from both the harvesting and processing of 1 million board feet of timber in Washington State is equal to 8.67 full time jobs. These jobs were divided between logging jobs, mill jobs, and wood product manufacturers (Table 3.11.9). Not every county contains mills or wood product manufacturers.

Table 3.11.8. Jobs Created for Each Million Board Feet of Timber Harvested in Washington State (Reproduced From Mason and Lippke 2007)

	Logging	Sawn wood	Secondary wood products[a]	Primary Paper products[b]	Total
Direct employment	1.30	2.97	3.26	1.13	8.67
Indirect employment	0.53	1.14	0.83	0.12	2.62
Total	1.83	4.81	4.09	1.25	11.28

[a] Secondary wood products include manufactured wood products such as doors, molding, and furniture.
[b] Primary paper products are pulp and paper manufactured from pulp logs and wood chips.

The Washington Employment Security Department 2016 estimates that seasonally adjusted monthly employment in the "Logging" sector in Washington State ranged from 3,600 and 4,100 from January 2014 to December 2015. Over the same period, employment in the "Wood Products Manufacturing" sector increased from 13,400 to 13,900. The Washington Employment Security Department does not provide estimates of employment in other sectors which trust lands may support, such as outdoor recreation or non-timber forest product collection. However, employment in in the broad category of "Arts, Entertainment and Recreation" ranged from 46,100 to 49,100. The source data do not show the wages associated with these jobs or whether these jobs are full or part-time. Briceno and Schundler 2015 estimated that approximately 200,000 full- and part-time jobs are supported by recreation in Washington.

Table 3.11.9. December 2015 Employment Information for Each County With State Trust Lands in the Analysis Area

County	% of total county paid employees in logging and wood product manufacturing sectors[a]	Unemployment rate[b]	Socioeconomic resiliency	Economic diversity (4 = high diversity)	Population, 2015
Clallam	4%	8.3 %	Medium	3	72,650
Cowlitz	4%	7.5 %	High	4	104,280
Grays Harbor	5%	9.3 %	Medium	3	73,110
Island	<1%	6.1 %	High	3	80,600
Jefferson	1%	7.3 %	Medium	3	30,880
King	<1%	4.5 %	High	4	2,052,800
Kitsap	<1%	5.5 %	High	4	258,200
Kittitas	1%	6.3 %	Medium	2	42,670
Lewis	4%	8.3 %	Medium	3	76,660
Mason	3%	7.9 %	Medium	2	62,200
Pacific	25%	9.5 %	Low	2	21,210
Pierce	<1%	6.1 %	High	4	830,120
San Juan	n/a	5.7 %	Medium	2	16,180
Skagit	<1%	7.0 %	High	4	120,620
Snohomish	<1%	5.0 %	High	4	757,600
Thurston	<1%	5.9 %	High	4	267,410
Wahkiakum	17%	9.0 %	Low	1	3,980
Whatcom	2%	5.9 %	High	4	209,790
Statewide rate		5.9 %	N/A	N/A	

[a] Estimated using 2014 County Business Patterns Census Data, http://censtats.census.gov/cgi-bin/cbpnaic/cbpcomp.pl
[b] Non-seasonally-adjusted Unemployment Rate (Washington Employment Security Department 2016).

As illustrated in Table 3.11.9, most counties have a low percentage of total paid employees identified by the U.S. Census as working in the logging or wood product manufacturing sectors. Pacific and Wahkiakum counties had the highest percentage of their paid employees employed in the logging or wood product manufacturing sectors (U.S. Census 2014). These two counties also had the highest and third-highest unemployment rates, respectively, of counties in the analysis area, making their economic resilience to changes in these sectors low.

Statewide, the annual unemployment rate has fallen every year since 2010 from 9.9 percent to 6.3 percent. The unemployment rate in Washington has closely tracked the nationwide rate since the 1990s, though with higher state-level unemployment in economic downturns (OFM 2016b).

Carbon sequestration

Currently, no trust lands generate revenue though the sale of credit for carbon sequestration, and there is no program applicable to these lands.

Environmental services and other non-market values

Estimating the value of DNR-managed timber lands beyond markets directly related to timber production requires looking at estimates of the value of environmental services and other land uses provided by forestlands.

ENVIRONMENTAL SERVICES AND CONSERVATION VALUES

Surveys have been developed to understand these non-market values and assess the value of different management options. For example, Garber-Yonts and others 2004 studied Oregon residents' willingness to pay for conservation in the Oregon Coast Range. They found that a hypothetical policy to increase the area of forests with old-growth characteristics resulted in a willingness to pay of up to $380 per household per year. Willingness to pay for large (40 to 180 square miles) biodiversity reserves peaked at $45 per household per year. For all conservation polices, willingness to pay for additional conservation peaked at moderate levels of conservation and was negative for all policies at high levels of conservation.

Some people place value on the continued survival of species. Richardson and Loomis 2009 reviewed studies valuing preservation of threatened, endangered, and rare species. They found that willingness to pay for protection of these species ranged from $8 to $311 per year per household.

Cedar River Group and others 2002 studied the value of the property attributes a 4,800-acre block of trust land on Blanchard Mountain in Skagit County. These attributes included 18 different non-timber social, environmental, and economic resources. They found that the total value of these resources to Skagit and Whatcom county residents was $8.5 million. The study does not assess how this value may change with different levels of timber harvest.

Briceno and Schundler 2015 estimated that land and waters that provide recreation experiences also provide at least $137 billion to $253 billion (2015 dollars) in economic benefits from clean water, wildlife habitat, aesthetic attributes, and enhanced recreation experiences for the entire state.

RECREATION

Across Washington State, recreation is an important contributor to the economy. Briceno and Schundler 2015, in a report for the Washington State Recreation and Conservation Office, estimated that recreation expenditures, excluding equipment, related to trust lands was $456 million per year (2015 dollars).

DNR-managed lands provide opportunities for recreation. Section 4.7 discusses the impacts of the alternatives to recreation opportunities. The value of these opportunities has not been studied in detail for all trust lands in the marbled murrelet analysis area. However, the value of one area, trust lands on Blanchard Mountain in Skagit County, have been studied. There, the Cedar River Group and others 2002 estimated that between 30,000 and 50,000 people visited the 4,800-acre block of trust lands. The economic impact of these visits to Skagit and Whatcom counties was $534,000 per year. They compared this value to the estimated value of harvest of 2 million board feet. This harvest level provided $1.6 million per year in economic impact to Skagit and Whatcom counties. The economic impact of these activities to the entire state is estimated as greater than $938,000 per year for recreation and $6.6 million per year for harvest of 2 million board feet.

MINERALS AND HYDROCARBONS

The analysis leases in this category include surface mining leases for rock, sand, and gravel and prospecting leases for minerals or hydrocarbons. Nearly all of this revenue comes from the surface mining leases. The total revenue to the trusts in the analysis area from surface mining grew from fiscal year 2011 to 2015 from $594,000 to $1.1 million. This revenue comes from royalties from two surface mines. The revenue varies as extraction volume changes. No new surface mine leases are currently planned.

HARVEST OF NON-TIMBER FOREST PRODUCTS

Collection of non-timber forest products for non-tribal uses is allowed with a valid permit. Collection for tribal use does not require a permit. Permits are issued by the region. The price varies—permits for small quantities of firewood are free, while other permits are priced in a bid process. Revenue from the collection of non-timber forest product on trust lands statewide is about $500,000 annually (2015 dollars), mostly from western Washington.

Existing policies and regulations

Trust distribution rate

Revenue generated for the trusts is split between the trust beneficiaries and the DNR's management funds. The distribution rate of funds to the beneficiaries and DNR's management accounts[31] differs between the federally granted trusts, State Forest Transfer Trust, and State Forest Purchase Trust (Table 3.11.10). One federally granted trust, the Agriculture School Grant, receives 100 percent of the revenue for activity on the lands in that trust (DNR 2015). The Legislature sets the maximum allowable distribution to DNR's management funds. The Board of Natural Resources sets the rate received by these funds within this limit. These rates have changed over time.

Revenue from State Forest Transfer and State Forest Purchase trusts is distributed within counties based on junior tax districts, which are tax districts created to fund particular services such as schools, emergency services, and libraries. Junior tax districts may receive a proportion of the revenue generated within the district. The proportion of the revenue they receive depends on factors such as the number of tax districts receiving revenue and the tax rate within the district as directed by RCW 76.64.110.

Table 3.11.10. General Distribution Rates, Upland Trust Revenue as of January 2016

Trust group	Beneficiaries	State general fund	DNR management accounts
Federally granted trusts	69%	0%	31%
State Forest Transfer	75%	0%	25%
State Forest Purchase	26.5%	23.5%	50%

[31] These accounts are the Resource Management Cost Account and the Forest Development Account. The Resource Management Cost Account receives money from the federally granted trusts. The Forest Development Account receives money from the State Forest Transfer and State Forest Purchase lands.

Tax rates

The state timber tax is applied to harvests on private and state lands. The current rate is 5 percent of the stumpage value (Washington Department of Revenue 2016a). [32] Revenue from this tax is split between the state general fund and counties, with 20 percent going to the general fund and 80 percent to the county where the harvest occurred. Sales tax varies by location due to local taxes in addition to the 6.5 percent state sales tax. There are numerous other state and local taxes in counties in the marbled murrelet analysis area. Current state tax rates can be accessed at the Washington Department of Revenue. Other tax rates are available from county governments.

[32] Stumpage is the price of standing timber or the right to harvest timber. Stumpage does not include costs of harvesting or transporting timber.

3.12 Cultural and Historic Resources

This section describes cultural and historic resources commonly found within the analysis area and how DNR manages those resources.

Text Box 3.12.1

How are cultural resources investigated in the field?

DNR has its own archaeological staff and cultural resource technicians. DNR also works closely with Tribal staff to locate and document cultural resources.

Photo: Sara Palmer

Why are cultural and historic resources important?

DNR-managed lands within the analysis area contain many types of cultural and historic resources. DNR routinely surveys for these resources as part of its forest practices. DNR works with tribes to ensure protection of and access to traditional cultural materials and foods, as well as sites of cultural importance to tribal communities.

Current conditions

Washington State law (WAC 222-16-010) defines cultural resources for forest practices as "archaeological and historic sites and artifacts and traditional religious, ceremonial, and social uses and activities of affected Indian Tribes." Cultural and historic resources on DNR-managed lands include archaeological and historic sites, resources, and objects.[33] Common examples on state trust lands include logging railroad grades, logging camps, mining camps, homesteads, and culturally modified trees. Logging railroad grades are the most common archaeological site type found on DNR-managed lands.

Traditional cultural properties, materials, and foods are also found on DNR-managed lands. These are places that have been identified as playing a significant role in a community's historically rooted beliefs, customs, and practices. Traditional cultural properties are eligible for listing in the National Register of Historic Places (refer to the following section). Traditional cultural materials and foods include many plants, fish, animals, and minerals traditionally used for food, medicine, and raw materials by Native peoples. There are 25 federally recognized Tribes within the analysis area.[34] Maintaining Tribal access to state lands for cultural practices, including the harvest of traditional plants, fish, roots, berries, wildlife,

[33] See WAC 25-48-020, sections 9-11.

[34] For a list of federally recognized tribes in Washington, refer to www.goia.wa.gov/Tribal-Directory/TribalDirectory.pdf.

cedar bark, and bough, is an important part of DNR's stewardship of state lands. Use of these resources is part of treaty rights for some tribes.

Existing policies and regulations

DNR review and consultation

DNR's practice is to avoid impacts to cultural resources when managing forestlands. Field staff routinely survey for cultural resources as part of forest practices. The 2006 *Policy for Sustainable Forests* directs the department to identify and protect significant historic and archaeological sites, consistent with state and federal law, and to work with tribes and interested stakeholders to address culturally significant areas.[35] DNR consults with the Department of Archaeology and Historic Preservation (DAHP) and affected tribes to ensure avoidance and protection of cultural and historic resources. Tribes and DAHP regularly review and provide input for proposed forest management activities to ensure that areas of cultural significance are not disturbed.

Federal review and consultation

The issuance of an ESA incidental take permit is considered a federal undertaking. The principal federal law addressing cultural resources is the National Historic Preservation Act (NHPA) of 1966 as amended (54 United States Code, Section 300101 et seq.) and its implementing regulations (36 CFR, Part 800), which address compliance with Section 106 of the NHPA. The regulations describe the process for identifying and evaluating historic properties, assessing the effects of federal actions on historic properties, and consulting with interested parties, including the State Historic Preservation Officer, to develop measures that would avoid, reduce, or minimize adverse effects. Federal consultation with federally recognized Tribes is also mandatory, where applicable.[36]

Under the NHPA, the term "historic properties" refers to cultural resources that are listed on or meet specific criteria of eligibility for listing on the National Register of Historic Places. These criteria include the resource is at least 50-years old (generally), demonstrates historical significance, and meets other criteria relating to significant historical use or contribution. Section 106 of the NHPA describes the procedures for identifying and evaluating eligible properties, assessing the effects of federal actions on eligible properties, and consulting to avoid, reduce, or minimize adverse effects. Section 106 does not require preservation of historic properties but ensures that decisions of federal agencies include meaningful consideration of cultural and historic values and options to protect those properties.

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[35] Several state and federal laws address these resources, including Archaeological Sites and Resources (RCW 27-53), Forest Practices Application approval (WAC 222-16-010), SEPA (WAC 197-11-960), and Section 106 of the National Historic Preservation Act. Department policies and procedures addressing this topic include Executive Order 05-05, Commissioner's Order on Tribal Relations, Identifying and Protecting Cultural Resources (PR 14-004-030), Interim Direction on Special Ecological Features and Archaeological Resources (PO 14-012), and the Cultural Resources Inadvertent Discovery Guidelines.

[36] Also refer to Fish and Wildlife Native American Policy (2016); Department of Interior's Policy on Consultation with Indian Tribes and Alaska Native Corporations (512 DM 4).

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Chapter 4

ENVIRONMENTAL CONSEQUENCES

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Chapter 4

Environmental Consequences

This chapter identifies any potential impacts under each alternative on the affected environment described in Chapter 3. Potential mitigation is identified where necessary.

■ Identifying impacts

Because the alternatives are limited to evaluating different approaches for marbled murrelet conservation, identifying adverse impacts to natural resources can be challenging. By design, the alternatives do not propose changing any other management approaches other than the marbled murrelet conservation strategy. Because of this, we would not expect considerable adverse impacts to other resources. Nevertheless, there can be subtle, indirect, and/or cumulative impacts that occur to natural resources due to the varying degrees of conservation proposed for marbled murrelets under the alternatives. It is the intent of this chapter to assess and understand, to the best we can, what impacts might occur to the natural and built environment from the different alternatives.

■ Asking the right questions

Each section of this chapter begins with questions that provide a framework for the analysis of environmental consequences. These "analysis questions" are designed to focus specifically on aspects of the environment likely to be impacted by the alternatives.

■ Evaluation criteria and measures

Determining whether there is an impact from the alternatives requires a methodology to evaluate whether and how an action alternative changes or affects the current conditions under the no action alternative. For some elements of the environment (such as climate and marbled murrelet populations), environmental conditions will change even under the no action alternative. These changes are also evaluated.

Evaluation criteria rely on the existing conservation or management objectives, policies, or rules that are being and would continue to be implemented under the no action alternative. *Measures* either qualitatively or quantitatively identify changes that the action alternatives create to elements of the environment relative to these criteria. Each section of this chapter identifies the evaluation criteria and measures used.

Determining the level of impact

This DEIS is designed to meet the requirements of both SEPA and NEPA. Both laws require the DEIS to evaluate adverse impacts. NEPA requires the identification of impacts that can be either beneficial or adverse.

CONSIDERING SCALE AND CONTEXT

The analysis area covers over 1.3 million acres of DNR-managed land. The evaluation of impacts must consider whether identified potential impacts are significant relative to scale and context. The impact of an alternative on a single campground, for example, may not be significant when looked at in the context of available recreation facilities within the scale of analysis area, but that could be different when considered locally. Most alternatives are evaluated at the analysis area scale, although some are looked at by planning unit or county where appropriate data may be available to measure the potential impact.

CONSIDERING INTENSITY

The term “intensity” refers to the severity of the impact. Intensity considers the duration and/or level of the impact. Some impacts can be relatively short in duration, and others may have longer-term consequences for an element of the environment. Indirect and cumulative impacts are also considered when determining the overall intensity of an impact to an element of the environment.

4.1 Earth: Geology and Soils

This section describes the potential effects of the alternatives on landslide potential and soil resources in the analysis area.

Analysis question

- *Would the action alternatives affect the potential for landslides or increase soil erosion or compaction within the analysis area?*

Evaluation criteria

This analysis considers the existing policies, regulations, and procedures in place to protect soil resources and soil productivity and address landslide hazards, including the *Washington State Forest Practices Board Manual*, *Policy for Sustainable Forests*, and the 1997 HCP.

Scale of analysis

As described in Chapter 1, this DEIS is considering DNR activities at the strategic level. Therefore, the scale of analysis for negative impact to soils and landslide hazards is the analysis area, with some additional analysis conducted at smaller scales to understand how marbled murrelet-specific conservation would overlap with areas of potential slope instability.

How impacts are measured

Impacts to soil resources or areas of landslide potential are measured qualitatively, based on whether the proposed action alternatives would affect consistency with forest practices rules and other best management practices to protect potentially unstable slopes or whether the alternatives would increase potential for soil damage from forest management activities.

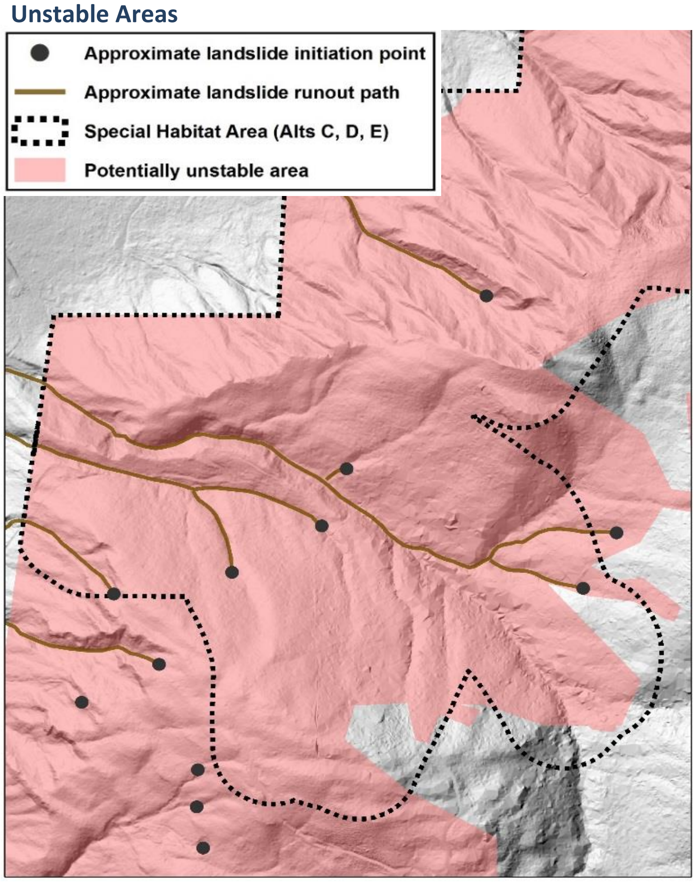
Summary of direct, indirect, and cumulative impacts

Effects on soil productivity, risk of compaction, and erosion

Standard best management practices to minimize erosion include placing crushed surface rock on roads. Photo: DNR

Because timber harvest activities are limited in areas of long-term forest cover (LTFC), the proposed action alternatives are not likely to increase levels of surface erosion or compaction or otherwise adversely impact soil productivity. All action alternatives except Alternative B add conservation acres to LTFC. However, even with the reduction of approximately 27,000 acres of LTFC under Alternative B (compared with the no action alternative), all existing policies and regulations governing forest practices that manage for soil productivity would remain. This would also apply to any area that is currently protected as marbled murrelet habitat under the interim strategy but may become available for management as conservation areas shift under the action alternatives.

Figure 4.1.1. Example of Special Habitat Area With Potentially Unstable Areas



Risk of landslides

In marbled murrelet conservation areas, restrictions on harvest, thinning, road building, and related activities mean that active management will be limited. Some of these conservation areas are mapped as potentially unstable, but this does not mean they are definitely at risk of a landslide occurring during the planning period.

Figure 4.1.1 illustrates an area where a proposed special habitat area overlaps an area indicated in DNR's GIS data as having potential landslide hazard risk. It is important to recognize that the area identified as potentially unstable in Figure 4.1.1 may be an overestimation of where the landslide risk specifically exists. Field verifications would be needed to more precisely analyze where the landslide risk is likeliest. The figure shows areas (landslide initiation points and runout paths) where actual landslides occurred following an extreme storm event in 2009.

Lands identified as potentially unstable would continue to be managed as provided for under current regulations, policies, and procedures, which are designed to minimize landslide risks. For these reasons, there is no expected increased landslide risk compared with current conditions, even on the 27,000 more acres made available for active management under Alternative B (as compared with the no action alternative).

Under any alternative, additional lands could be designated as a potentially unstable slope in the future, or land currently designated could be removed from that designation. No changes in the management of these areas are anticipated as a result of the proposed action.

Conclusions

Under all alternatives, including the no action alternative, DNR would continue to minimize the potential for landslides and damaging impacts to soils through the existing regulatory framework. This includes the 27,000 acres of land that would no longer remain in the interim conservation strategy for murrelets under Alternative B. Some areas of potential slope instability or high erosion potential would be included in marbled murrelet conservation areas, but forest management activities would be restricted in these areas. Table 4.1.1 summarizes these conclusions.

Table 4.1.1. Summary of Potential Impacts to Geology and Soils

Key questions	Criteria	Measures	Potential impacts
Would the alternatives affect the potential for landslides or increase soil erosion or compaction within the analysis area?	Whether the alternatives would reduce DNR's ability to protect soils. Consistency with Washington State Forest Practices Rules and other best management practices to protect potentially unstable slopes. Whether the alternatives would increase potential for soil damage from forest management activities.	Acres currently deferred that would no longer have restrictions for marbled murrelet. Net acreage of LTFC under each alternative. Acres of potentially unstable slopes. Percentage of LTFC that is potentially unstable slope. Percentage of potentially unstable slopes in interior forest.	None. No alternative would increase risks to soils or increase landslide potential. Compared with the no action alternative, Alternative B slightly increases the acreage available for new timber harvest and road building, but the existing regulatory framework designed to minimize soil impacts from these activities would apply to these areas.

4.2 Climate

This section evaluates possible relationships between the marbled murrelet conservation strategy alternatives and climate change.

Analysis questions

- *Do any alternatives cause more greenhouse gases to be emitted than sequestered?*
- *What effects will climate change have on the action alternatives or their expected environmental impacts?*

Evaluation criteria

Carbon sequestration in the analysis area and potential climate-related impacts to elements of the environment, particularly loss of complex forest structure in LTFC, are the primary measures used in this analysis to evaluate the relationship between the alternatives and climate change.

Greenhouse gas emissions and carbon sequestration

The 2016 guidance from the Council on Environmental Quality (CEQ) recommends that "agencies use the projected GHG emissions associated with proposed actions as a proxy for assessing proposed actions' potential effects on climate change in NEPA analysis." CEQ allows for a qualitative analysis where agencies do not have reasonable available data to support calculations for a quantitative analysis.

Text Box 3.2.1

Do the alternatives influence carbon sequestration?

All alternatives are likely to increase the amount of carbon sequestered by DNR-managed forests.

DNR does not have data on how much basal area will be removed from each stand in the future, how much basal area remains in each stand following a treatment, and how much carbon is sequestered through time as each thinned or unharvested stand grows. Without such data, a quantitative analysis is difficult and would likely produce questionable results. Given the lack of quantitative data, this carbon analysis uses principles to develop a relative ranking of proposed alternative impacts to a changing climate.

As described in detail below, our analysis concludes that all alternatives are likely to result in more carbon sequestered than emissions generated. Because the proposed action is to develop a long-term conservation strategy for marbled murrelets, all alternatives are analyzed based on area conserved rather than area harvested.

Climate-related effects on elements of the environment

Potential impacts of climate change to elements of the natural environment within the analysis area are evaluated below. The analysis focuses particularly on forest structure within LTFC, evaluating whether potential climate-related declines in complex forest structure would be exacerbated by area conserved under each alternative. We chose to focus on complex forest structure within LTFC because complex forest structure is more likely to provide marbled murrelet nesting habitat, and the intent of a long-term strategy is to conserve and promote nesting habitat within LTFC. Potential impacts of climate change to marbled murrelets are further discussed in Chapter 5.

Scale of analysis

Carbon sequestration is analyzed at the scale of DNR-managed lands in western Washington. This is appropriate because a determination of net carbon emissions for each alternative must consider both the carbon sequestration in the analysis area and the emissions from managing the same area.

The analysis to determine whether the alternatives exacerbate the impacts of climate change on the environment is analyzed at the same scale. While climate will influence the future forests of Washington, including DNR-managed lands, the science to date cannot be applied at an individual DNR-managed stand level scale.

How impacts are measured—carbon sequestration

Our analysis assumes that carbon emissions, which contribute to climate change, are greater than carbon sequestered if any of the following conditions are met:

1. If DNR harvests older stands and replaces them with stands to be harvested on shorter rotations;
2. If DNR's final harvest rotation shortens with time; or
3. If volume, and by association carbon, removed by thinning is greater than residual stand volume growth.

These conditions rarely, if ever, occur on DNR-managed lands. Due to various policies already in place, in addition to lands included under most of the alternatives, DNR effectively does not harvest older forest stands. All alternatives assume DNR does not change the age when a final harvest is conducted. Therefore, the rotation length does not shorten. Even under Alternative B, more currently harvestable land may remain available to harvest, but the rotation length is not assumed to change. While this condition is likely true on lands managed for short rotations (i.e., scheduled for final harvest sometime after thinning), the condition does not apply to DNR-managed lands that are periodically thinned but never final harvested, as is found in LTFC lands.[1]

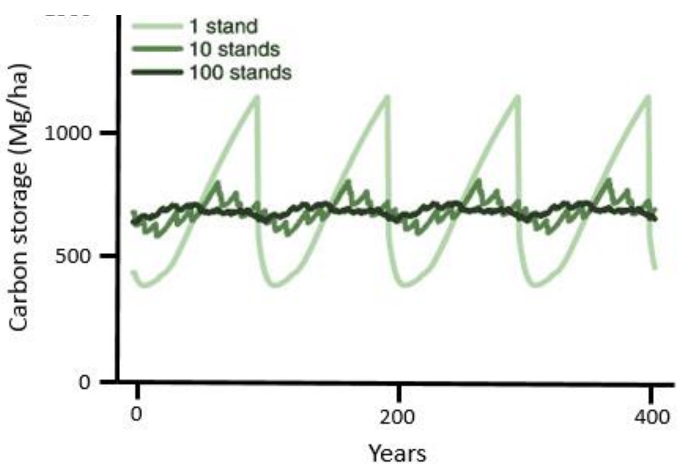
[1] This analysis does not include quantitative data about harvest or thinning acres or volumes. Potential harvest schedules are being developed as part of an update to the sustainable harvest calculation (currently being drafted).

Given these factors, we can expect the following principles to apply to the analysis area:

HARVEST ROTATIONS

1. *Across the landscape and through time, lands that DNR manages on final-harvest rotations are in a steady-state carbon balance because the frequency of final harvests does not change over time, and there is no additional acreage being converted from old growth to second growth. This means the overall impact of harvesting to the carbon balance on DNR's forested land base for the life of the HCP is neutral.* This principle is partly illustrated in Figure 4.2.1 where the carbon stored in a single managed stand greatly varies with time; however, because different stands are harvested in different years, the overall variation in carbon storage across the entire landscape is neutral. If harvest frequencies would increase with time, both the graph and principle would no longer be correct.

Figure 4.2.1. Variation in Carbon Storage at Different Spatial Scales (Adapted from McKinley and others 2011)



Note the average carbon store remains similar across scales, but the range in carbon storage differs depending on whether one examines a single stand or stands of varying ages across a landscape.

When the entire wood product life cycle is considered, the total amount of carbon stored may increase with time as carbon from harvested trees remains in some durable wood products like lumber (Figure 4.2.2). However, after accounting for typical wood product fates, that additional carbon storage accumulates only slowly, taking well over 400 years to recover toward old-growth storage levels on a per-acre basis (dashed line in Figure 4.2.2). With repeated 60-year rotation, the time required to achieve the same amount of old-growth carbon storage is much slower than that attained by simply letting stands age (steep rises preceding harvests on Figure 4.2.2) and is sufficiently slow that any additional carbon stored in wood products during a single 60-year harvest rotation (and the life of the HCP) is slight (Figure 4.2.2). Please note we use the example of old growth to illustrate the principle. DNR's current policies preclude the actual harvest of old-growth forests.

Figure 4.2.2. Variation in Carbon Storage Under 60-Year Rotations (Adapted from Harmon and others 1990)

This graph illustrates the additional carbon storage gained when wood products (called "wood stored" in the figure) are included in a carbon analysis.

The current DNR land base within the analysis area is largely comprised of highly productive forested lands. If climate change were to reduce forest productivity, the total amount of sequestered carbon across the landscape would lower but would still result in neutral sequestration patterns as shown in Figure 4.2.1. Carbon released by vehicles and equipment related to timber sales would also lower the total amount of carbon sequestered. However, such annual emissions would be largely uniform though the life of the HCP assuming no shortening of harvest rotation length, thereby resulting in a neutral carbon balance.

THINNING TREATMENTS IN LTFC

2. *On DNR-managed lands in the analysis area, the carbon removed from a thinning treatment in stands with no final harvest will be less than carbon eventually sequestered in the residual trees. The overall impact of these treatments to the carbon balance would be neutral to positive.* Studies of Douglas fir in the Pacific Northwest have shown that volume removed from repeated thinning entries is greater than the residual volume growth on stands with 50-year rotations (Curtis and others 1997, Curtis and Marshall 2009); however, due to continued rapid growth following thinning, the studies also concluded that residual live tree volume would exceed volume removed with moderately extended rotations. This result suggests carbon sequestered in thinned (from below) stands without a final harvest should generally exceed thinning-related carbon loss. While stand ages vary on DNR-managed lands in this management category, many stands that already have or might be thinned within LTFC would exceed 50 years at the end of the HCP. Furthermore, the previously cited studies typically included five thinning treatments whereas the DNR lands in this category may have one or two treatments during the remainder of the HCP, and therefore are likely to near or exceed a positive carbon balance. Taken together, more volume, and therefore carbon, will generally remain in stands through time on thinned acres relative to the volume removed from thinning treatments.

UNMANAGED LTFC

3. *The more acreage added to unmanaged LTFC, the greater the sequestration benefit*. The most effective way to sequester carbon within these forests is to allow them to age (Mackey and others 2013, Keith and others 2014). As illustrated in Figures 3.2.1 and 3.2.2, it would take several centuries of 50–60 year final harvests to achieve the same level of carbon storage as is found within intact old forests, and the rate of carbon storage is much slower than that by letting forests age. Alternatives with more acres in LTFC will sequester more carbon than those with fewer acres in LTFC.

Summary of direct, indirect, and cumulative impacts

Greenhouse gas emissions and carbon sequestration

Alternative B would potentially emit more greenhouse gases related to harvest activities[2] than the no action alternative (Alternative A) because Alternative B releases 27,000 acres of forest for potential harvest. Emissions will likely decrease under Alternatives C through F relative to the no action alternative because these alternatives make fewer acres available for harvest.

The most carbon would be sequestered under Alternative F, followed by Alternatives E, C, D, A, and B in that order. Although listed in order of the amount of carbon sequestered, the absolute difference in carbon stored among Action Alternatives B, C, D, and E is likely minimal because of the narrow difference in acres in LTFC. Because all alternatives sequester more carbon than is emitted, this analysis concludes that no alternative likely results in a significant adverse impact to climate change from emissions.

Text Box 3.2.3

Will climate change be affected by changes in carbon sequestration under the alternatives?

Because all alternatives sequester more carbon than is emitted, no alternative results in a significant adverse impact.

[2] As stated in Chapter 3.2, carbon is the leading type of greenhouse gas emitted from DNR forest management activities and therefore is the focus of this analysis.

Impacts of climate change on elements of the environment critical to a long-term conservation strategy

VEGETATION

Growth and retention of structurally complex forest throughout the planning period is a key component to the success of a long-term conservation strategy. Forest growth (productivity) is affected by climate change. For reasons noted in Chapter 3.2, forest productivity will increase or decrease seasonally and annually depending on tree species and location (Littell and others 2008, Peterson and Peterson 2001, Stephenson 1990, 1998). However, broad generalizations about productivity can be made based on current energy and moisture limitations (Milne and others 2002, McKenzie and others 2003, Littell and Peterson 2005). For example, while low elevation lands in the Puget Trough and the northeast portion of the Olympic Peninsula are more likely to decline in productivity with increasing temperatures and moisture stress, this loss might be offset by increased forest productivity at higher elevations and other locations where warming temperatures extend the growing season. Yet even with increases in annual tree productivity, warmer and drier summers, combined with more intense droughts, will increase summer moisture stress and likely reduce summer productivity, even in some locations that are currently energy-limited. What is unclear is if such declines in summer productivity will more than offset increases in productivity during the rest of the year. With both increases and decreases in forest productivity likely, habitat goals could be reached sooner or later in different portions of DNR-managed lands. Overall, it is not yet possible to conclude when climate-related influences to forest productivity on DNR-managed lands within LTFC will be positive, negative, or neutral through the planning period. No significant productivity differences are anticipated within LTFC between the no action alternative and the action alternatives, nor between action alternatives.

Text Box 3.2.2

Are older forests more resilient to climate change?

Conserving older forest while allowing forests to grow with minimal human intervention is a reasonable strategy to promote west-side forest resistance under a changing climate. Thinning to accelerate late-successional conditions in younger second-growth forests can help facilitate the goal of forest resilience.

Forest conditions can be changed through management. Thinning to accelerate late-successional conditions in younger second-growth forests could increase forest resilience because it may reduce drought-related stress in younger and more moisture-sensitive trees and foster structural and compositional diversity at both the landscape scale (since most of the landscape is young to mid-seral and old forest therefore provides some complement) and at the stand scale (since older forests have the broadest range of tree sizes and species). Thinning will occur in LTFC on a limited basis, primarily outside marbled murrelet conservation areas (with the exception of MMMAs and emphasis areas) and with a purpose to accelerate development of structurally complex forest.

DISTURBANCE

The forests of western Washington have evolved with largely stand-replacing disturbance events for millennia (Agee 1993). Episodic wind events have and continue to affect coastal Washington forests, but their influence in the rest of western Washington is more muted. While both wind and insects have helped shape the forests, fire has historically been the key driver of broad-scale stand initiation and related structural development across western Washington (Franklin and others 2002). For example, the Yacolt Burn of 1902 burned approximately 239,000 acres of forest in Clark, Cowlitz, and Skamania counties in less than a week. Importantly, the forests of western Washington are rarely fuel-limited; the maritime climate largely limits wildfires in these forests. As such, these forests are therefore both adapted and resilient to stand-replacing disturbance regimes. While these forests have been resilient to stand-replacing disturbances in the past, future resilience to such disturbances becomes less certain with time as the climate changes. Based on the long-term relationship between stand-replacing disturbances and western Washington forests, maintaining existing forest cover is a reasonable strategy to promote west-side forest resistance (e.g., forestall change) and resilience under a changing climate. Retaining older forested stands would help resist eventual change because older trees are better able to persist through unfavorable conditions created by disturbances than young trees and seedlings.

In addition, promoting well-distributed habitat patches is likely better than few, large patches to better increase the probability that some habitat will persist when a wildfire occurs (which will eventually happen). With projected increases in wildfire, some may argue for a more active management approach to reduce potential future wildfire severity. However, such a goal cannot be attained without fundamentally altering the structure of these systems and thus affecting the forest's value as murrelet habitat.

EARTH

As described in Section 3.1, management of potentially unstable slopes and soils will be the same under each of the action alternatives as under the no action alternative. Management of potentially unstable slopes are designed to minimize the impacts of activities. These impacts will continue to be minimized. Any future changes in landslide timing, frequency, or severity due to climate change will likely be similar across all of the alternatives.

AQUATIC RESOURCES

As described in Section 3.2, changes in vegetation composition and disturbance are expected due to climate change. Timing, frequency, and severity of landslides are projected to change as well. These effects of climate change will impact aquatic resources. However, since the no action and action alternatives have similar amounts of activity in riparian areas and follow the same policies and procedures for management of riparian areas and watersheds (refer to Section 3.4), little difference in impacts to aquatic resources is expected between the action alternatives and the no action alternative. Likewise, there is little difference expected between action alternatives.

WILDLIFE

As described in Chapter 3.5, wildlife species can be organized into guilds. A guild is a group of species that utilizes the same class of resources in a similar way. The preceding analysis of impacts to vegetation shows that no difference in impacts due to climate change to vegetation is expected between the action alternatives and the no action alternative, and no difference is expected between action alternatives. Based on this conclusion, little difference in impact on wildlife guilds is expected between the action alternatives and the no action alternative, nor between action alternatives.

Similarly, little difference in impact of climate change on marbled murrelet or other endangered wildlife is expected between the action alternatives and the no action alternative, nor between action alternatives. Climate change impacts on the marbled murrelet are more specifically discussed in Chapter 5.

Conclusions

This analysis has determined that retaining more (and well-distributed) area in long-term forest cover sequesters more carbon, and, given trends in precipitation and temperature, increases resilience of LTFC by reducing uncertainty of disturbance and vegetation trends in specific locations and reducing the potential loss of LTFC to large, stand-replacing wildfire.

All alternatives distribute LTFC across the analysis area. Potential impacts from climate change on LTFC is likely lowest for Alternative F, owing to its addition of 114,000 acres of LTFC relative to the no action alternative. Alternatives C, D, and E also all increase LTFC area relative to Alternative A. Yet relative to Alternative A, Alternatives C, D, and E will all likely provide a similar level of benefit from a climate change perspective, with a maximum difference of approximately 20,000 acres across all four alternatives (including Alternative A). Any reduction in resilience to climate change impacts is probably slight under Alternative B, with a 27,000 acre LTFC decrease from the no action alternative (which is approximately 2 percent of DNR-managed lands in the analysis area).

This analysis concludes that none of the action alternatives will likely result in a net increase of greenhouse gas emissions or exacerbate impacts to elements of the environment from climate change.

Figure 4.2.3. Summary of Potential Impacts Related to Climate Change

Key questions	Criteria	Measures	Potential impacts
Do any alternatives cause more greenhouse gases to be emitted than sequestered?	Greenhouse gas emissions do not exceed sequestration	Potential carbon emission and sequestration on managed lands, thinned LTFC, and untouched LTFC lands	Sequestration is greater than emissions under all alternatives.
What effects will climate change have on the action alternatives or their expected environmental impacts?	Whether conservation or management approaches in LTFC exacerbate climate change impacts or reduce climate-related resilience	Differences in amount of LTFC Changes in management of elements of the environment Changes in complex forest structure	Climate change will have impacts on elements of the environment. However, the action alternatives are not expected to exacerbate these impacts. Relative to Alternative A, Alternatives C through F are expected to increase resilience of LTFC to climate change in similar ways. Alternative B would only slightly reduce resilience.

4.3 Vegetation

This section describes the potential effects of the alternatives on forest conditions, forest health, and vegetation in special management or conservation status.

Analysis questions

- *Do any of the action alternatives result in changed forest conditions that predispose forest stands to a specific detrimental effect or create the potential to spread insects, pathogens, or disturbance to other forest stands?*
- *Do any of the action alternatives affect the conservation status of old-growth forests, gene pool reserves, or rare plants?*
- *Do any of the action alternatives affect the conservation objectives of natural areas?*

Evaluation criteria

Scale of analysis

This analysis looks at vegetation across the analysis area and focuses on potential changes to forest conditions within proposed marbled murrelet conservation areas. Some specific natural areas are considered where vegetation management could be impacted by the alternatives.

How impacts are measured

Data on forest conditions are used to qualitatively assess whether forests in LTFC in the action alternatives are at any higher risk to forest health issues than forest in LTFC in the no action alternative. The analysis also looks at whether the alternatives would require significant changes to how rare plants, old growth, genetic resources, or natural areas are managed or otherwise affect the conservation status of these resources.

Summary of direct, indirect, and cumulative impacts

Based on the analysis below, no significant adverse effects are expected to general forest conditions as a result of the action alternatives. Some positive impacts are expected to vegetation benefitting from older forest conditions.

High-density stands

There is little change in the area of high-density (RD >85) forest in LTFC between Alternative A and action alternatives compared to the total acres of LTFC.

Where thinning can occur in high-density stands, a short-term risk of disturbance may develop (Mitchell 2000). Under the action alternatives, thinning would be limited in extent as described in Chapter 2. The area of marbled murrelet habitat or security forest subject to thinning under the action alternatives is expected to be a small percentage of the total habitat area, so the short-term risk to marbled murrelet habitat and security forest is expected to be low. In the long term, such treatments are expected to encourage the development of structurally complex forest and security forest.

Table 4.3.1. Change in High-density Forest (RD>85) in LTFC from the No Action Alternative (Alternative A; Rounded to Nearest 1,000), Beginning of the Planning Period

	Total acres	Acres change from Alternative A				
	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
RD >85	104,000	-4,000	2,000	0	3,000	17,000

For species benefitting from older forest conditions, there is a beneficial impact expected in LTFC due to more acres being in a protected status (refer to Section 3.7).

DNR-management and land use activities outside of LTFC would be the same under each action alternative. Forests will be harvested, thinned, and replanted pursuant to the sustainable harvest calculation, *Policy for Sustainable Forests*, Forest Practices rules, 1997 HCP, and associated laws, policies, and procedures as described throughout this DEIS; therefore, forest conditions outside LTFC are expected to be unaffected by the action alternatives.

Forest health risks

The sources of forest damage identified in the 2015 aerial forest health survey occur in both managed and unmanaged forests at approximately the same rates. Current rates of damage are small relative to the acres in the analysis area. Changes in management due to the action alternatives are not expected to change these overall rates of damage. Types of damage associated with smaller trees, such as bear damage, are expected to become less common as forests mature in LTFC. Areas of root disease are present in both managed and unmanaged stands, including areas of marbled murrelet habitat. However, root disease spreads slowly and does not affect each tree species equally. Due to this, root disease is not expected to pose a specific risk to marbled murrelet habitat.

Vegetation in special management or conservation status

LTFC under every alternative includes forestlands managed for conservation purposes pursuant to the 1997 HCP, DNR's *Policy for Sustainable Forests*, and/or state law. These lands are managed primarily to maintain biodiversity or unique natural features of regional or statewide significance. Conservation measures under the action alternatives were evaluated to determine if those measures would conflict with these existing conservation commitments.

OLD GROWTH, GENETIC RESOURCES, RARE PLANTS, AND UNCOMMON HABITATS

DNR policies protecting old growth and gene pool reserves would be unchanged by any alternative. Potential impacts to rare plants are already part of site-specific assessments conducted for forest management activities. However, because every location of every rare plant is not known, this vegetation can be at risk from forest management activities. Unknown occurrences of rare plants or plant communities would likely get an indirect conservation lift if they are located within a marbled murrelet conservation area that is protected from active forest management activities (for example, within an occupied site or a special habitat area).

NATURAL AREAS

Under the no action alternative, management of natural areas would continue as provided in state law and DNR management plans for these areas, with consultation between DNR and USFWS on any forest management or land use activities with potential to disturb marbled murrelet habitat.

The proposed conservation measures are not anticipated to impact the maintenance and development of marbled murrelet habitat on natural areas. Most conservation measures are compatible with management objectives for these lands. For example, no new roads are anticipated to be developed within natural areas. Existing roads are maintained for low-impact recreation or environmental education. No new leases or easements are issued in natural areas inconsistent with conservation goals; some existing property rights (for example, mineral exploration rights) may still exist where they were not acquired when DNR acquired the property.

Where special habitat areas, which include areas affected by conservation measures that prohibit most forest management activities, overlap with NAPs and NRCAs, some minor impacts could be expected. Alternative D proposes 965 acres of special habitat areas that overlap NAPs and over 2,500 acres that overlap NRCAs. Because Alternative D proposes prohibiting facility and trail development in special habitat areas, this could impact the development of future trails in some natural areas (although there are no specific trail plans within these areas and within special habitat areas at this time). Alternative E includes 426 acres of NAPs within its designated special habitat areas, but the proposed conservation measure for trail development is more flexible under this alternative. Non-motorized trail development may occur on some NRCAs for environmental education or low-impact recreation purposes. Motorized trails or uses are not allowed on NAPs or NRCAs.

Forest restoration treatments are planned for several coastal natural areas (Bone River NAP, Niawiakum River NAP, Ellsworth Creek NRCA, and Elk River NRCA). Thinning or removal of larger trees may occur to accelerate older forest characteristics. Marbled murrelet habitat considerations will be part of developing treatment prescriptions; therefore, impacts from the action alternatives on proposed restoration activities are anticipated to be minor or negligible.

Figure 4.3.1. Summary of Potential Impacts to Vegetation

Key questions	Criteria	Measures	Potential impacts
Do changed forest conditions predispose forest stands to a specific detrimental effect or create forest conditions with the potential to spread detrimental effects to other forest stands?	Acres of at-risk stands	Acres of forest health concerns Acres of high-density stands (RD >85) of disturbance	No increase in area of forest health concerns expected. Minimal change in area of high-density stands under the action alternatives.
Do any alternatives affect the conservation status of rare plants, old-growth forests, or gene pool reserves?	Conservation policies in *Policy for Sustainable Forests*, OESF forest land plan	Acres of vegetation in conservation status	The conservation status of rare plants, old-growth forest, or gene pool reserves would not be changed under any alternative. Rare plants whose locations are not currently known could receive an indirect benefit where they are included in marbled murrelet conservation areas and protected from active forest management.
Do any of the alternatives affect the conservation objectives of natural areas?	RCW 79.70 and NAP management plans; RCW 79.71 and NRCA management plans	Planned projects on NAPS or NRCAs	Alternatives D and E could limit the expansion or development of new low-impact trails for educational purposes in NAPs or NRCAs where special habitat areas overlap these lands. Forest restoration activities planned in NAPs or NRCAs might be affected by thinning limitations; however, a mitigation for these planned activities could be to follow a marbled murrelet habitat-enhancement treatment prescription.

4.4 Aquatic Resources

This section describes the potential effects of the alternatives on aquatic resources in the analysis area, focusing on key aquatic functions and habitat.

Analysis questions

- *How would the action alternatives affect riparian functions, including riparian habitat, wetlands, water quality and quantity, and fish populations and habitat?*
- *Would marbled murrelet conservation areas or measures restrict DNR's ability to conduct active management under the HCP riparian conservation strategies to restore functioning riparian habitat?*

Evaluation criteria

This section considers how proposed changes in LTFC configuration in and adjacent to aquatic resources could potentially alter key aquatic functions using the following criteria:

- Riparian habitat function is maintained. Key positive indicators of riparian function are large woody debris recruitment; stream shade, which is considered one of the primary factors influencing stream temperature; leaf and needle litter recruitment, which provides nutrients to streams that support the aquatic food chain; and microclimate (DNR 2013). Negative indicators of riparian habitat function are elevated peak flow, which refers to periods of high stream flow associated with storm events and spring snowmelt, and sediment delivery.
- Water quality is in compliance with state and federal water quality standards, specifically the federal Clean Water Act and the state Water Pollution Control Act (RCW Chapter 90.48).
- The criterion for fish habitat is functioning riparian habitat, with the same previously identified functional indicators.

The analysis also evaluates whether the action alternatives would affect DNR's ability to achieve the objectives of the 1997 HCP riparian conservation strategies.

Scale of analysis

Because the proposed action is a non-project action under SEPA[3] and takes place over a large landscape scale, this section cannot consider exactly when and where project-specific forest management activities would occur adjacent to aquatic resources. Those decisions would be made at the project-specific (operational) level of planning. This section considers overall trends and effects of the proposed alternatives on aquatic resources at the scale of the analysis area. The existing riparian conservation strategies and regulatory framework governing water and fish protection remain unchanged under the action alternatives.

How impacts are measured

Potential effects on aquatic resources are considered qualitatively, focusing on the degree to which the management of these resources and the resulting impacts to the key functions they provide might be changed by the proposed alternatives.

Summary of direct, indirect, and cumulative impacts

As described in Section 3.4, forest management activities that could affect aquatic resources are addressed by an extensive framework of regulations, policies, and plans. These include the Forest Practices Act and Board Manual, State Environmental Policy Act, the riparian conservation strategies of the 1997 HCP and the RFRS.

The proposed alternatives do not change this existing regulatory framework. DNR would continue to implement the riparian conservation strategy objectives of the 1997 HCP and OESF forest land plan, which are designed to achieve long-term, continuous landscape-level restoration of riparian functions over time. Therefore, no significant direct impacts to aquatic resources are expected as a result of implementing a long-term marbled murrelet conservation strategy under any of the alternatives.

Indirect adverse effects may occur as follows:

- Through localized increases in forest management activities that could occur in certain areas where current marbled murrelet restrictions would be lifted under one or more of the alternatives.
- Through conservation measures that limit potential harvest or thinning in some riparian areas (for example, within occupied sites or special habitat areas).

[3] Non-project actions are “governmental actions involving decisions on policies, plans, or programs that contain standards controlling use or modification of the environment, or that will govern a series of connected actions.” (SEPA Handbook, Chapter 4)

The following sections focus on these potential indirect effects of the alternatives on key functions of aquatic resources. These effects are generally considered to be minor or beneficial at the scale of the conservation strategy.

Indirect effects on key functions of aquatic resources

LARGE WOODY DEBRIS RECRUITMENT

DNR has defined riparian management zones based on the area of influence for large woody debris recruitment. The 1997 HCP riparian strategies are specifically designed to promote the long-term recovery of large woody debris recruitment potential within this zone.

Example of large woody debris. Photo: DNR

None of the action alternatives would significantly alter how DNR manages for large woody debris recruitment. Even on lands where potential timber harvest activities may increase under one or more of the alternatives, riparian buffers would remain that would continue to provide large woody debris.

Stream in peak flow condition. Photo: DNR

PEAK FLOW

The term “peak flow” refers to periods of high stream flow associated with storm events and spring snowmelt. In western Washington watersheds with significant snow, peak flow occurs during winter storms when heavy rain falls on top of an existing snow pack, dramatically increasing the amount of runoff. These are commonly referred to as “rain-on-snow” events.

Alternatives C, D, E and F would increase LTFC across the analysis area, which would have the potential to reduce peak flows, rather than increase them.

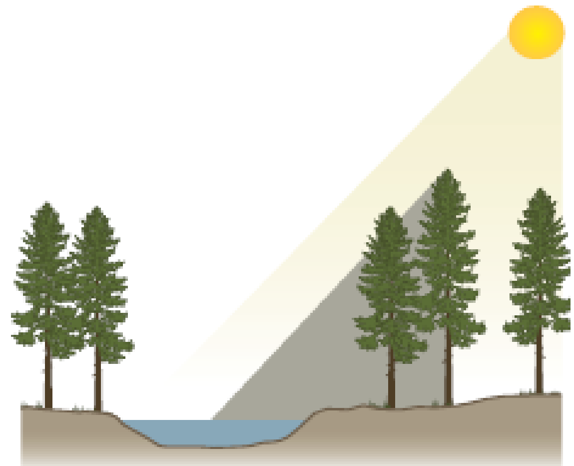
While Alternative B results in less LTFC than the no action alternative, it does not alter the DNR’s existing approach to address peak flows through DNR watershed-level planning. This approach ensures that measurable increases in peak flow conditions are avoided and are consistent with the *Policy for Sustainable Forests*, Forest Practices Act and Board Manual, and 1997 HCP (which includes objectives for hydrologic maturity in the rain-on-snow zone).

STREAM SHADE

Stream shade refers to the extent to which incoming sunlight that would otherwise shine on the stream channel is blocked by trees, hillslopes, or other features. Stream shade is considered a primary factor that keeps water temperatures sufficiently cool to support native fish species (Beschta and others 1997).

Accordingly, the Forest Practices Act and the 1997 HCP riparian conservation strategies specifically emphasize protection and restoration of stream shade. Therefore, even though some localized increases in timber harvest may occur under all action alternatives, the stream shade functions of riparian areas would be maintained under all alternatives as required by the existing riparian management framework, including the Forest Practices Act, Board Manual, and 1997 HCP.

Figure 4.4.1. Illustration of Stream Shade



FINE SEDIMENT DELIVERY

Increased levels of fine sediment can have detrimental effects on both water quality and fish habitat (Hicks and others 1991, Cederholm and Reid 1987). Forest roads and road-drainage features near streams are the most common source of fine sediment on state trust lands (DNR 1997, Potyondy and Geier 2011). The Forest Practices Act sets strict requirements for the design, operation, and maintenance of forest roads to avoid and minimize these impacts.

None of the action alternatives would substantially change the overall density of forest roads (refer to Section 4.8, Forest Roads). Additional miles of road may need to be built to avoid marbled murrelet habitat impacts. However, none of the action alternatives would alter existing forest practices regulations nor DNR procedures regarding road design and maintenance (refer to Section 4.8, Forest Roads). Therefore, none of the alternatives are likely to increase fine sediment delivery to wetlands, streams, or any other waters.

LEAF AND NEEDLE LITTER RECRUITMENT

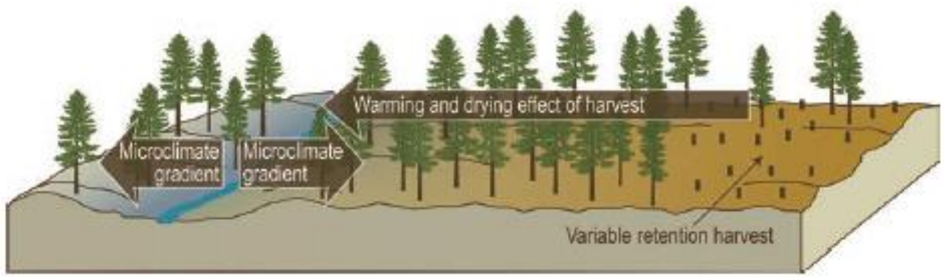
Leaf and needle litter are organic debris produced by the forest canopy that provide nutrients to streams that support the aquatic food chain. Leaf and needle litter accounts for the majority of nutrient inputs in small headwater streams and is critically important for the healthy function of these ecosystems (Wallace and others 1997).

Generally speaking, the majority of leaf and needle litter recruitment comes from vegetation within one site-potential tree height of a stream (FEMAT 1993), and these zones are already protected by the HCP riparian conservation strategies. Therefore, none of the alternatives are likely to alter leaf or needle litter recruitment.

MICROCLIMATE

Forest cover surrounding wetlands and streams creates a microclimate that lowers the temperature of air, soil, and water and increases humidity (Meehan 1991, Naiman 1992). Removing significant amounts of forest cover within or adjacent to riparian areas can alter microclimate and harm moisture-dependent species such as amphibians and a wide range of invertebrates, plants, and fungi (Spence and others 1996).

Figure 4.4.2. Timber Harvest Effects on Riparian Microclimate (Copied From OESF RDEIS)



Text Box 4.4.1

How do isolated riparian areas factor into aquatic resource impacts?

LTFC includes riparian areas that are less than 200 meters wide. These “stringers” are predominantly narrow riparian management zones where adjacent uplands have not been designated as LTFC.

Studies by Brosofske and others 1997 demonstrated that streams exert a cooling effect on both soil and air temperatures at distances of up to 164 feet from the stream. In addition, they noted increased relative humidity at distances up to 122 feet from the stream. The heating and drying effects of harvest can extend up to approximately 545 feet into the surrounding unharvested areas (Chen 1991, Chen and others 1995, FEMAT 1993).

Timber harvest may occur well within this 545-foot zone of influence, potentially affecting the microclimate in adjacent areas of LTFC. However, microclimate is a relatively small component of overall riparian health. Changes in microclimate are not expected to significantly affect riparian habitat function within LTFC or within the analysis area as a whole.

Using “stringer” configuration as a proxy for potential risk of changes to microclimate (refer to Text Box 4.4.1 and Chapter 2), only Alternative B would result in a net increase in stringer habitat across the entire analysis area (a 5 percent increase compared to current conditions under Alternative A). Under all other alternatives (Alternatives C, D, E and F), riparian management zones (RMZs) within the stringer configuration would decrease between 3 and 19 percent from current conditions in Alternative A. Forest cover adjacent to riparian habitat and associated microclimate function values would increase as forest stands within LTFC mature.

Indirect and cumulative effects on riparian restoration strategies: Limitations on active management

Some riparian harvest (including hardwood conversions) and thinning is allowed or even prescribed under the riparian restoration strategies of the 1997 HCP and the RFRS. Conservation measures proposed under the action alternatives would restrict harvest of riparian areas within occupied sites, buffers, MMMAs, special habitat areas, and P-stage 0.47 habitat identified in Alternatives C and E. These measures prohibit thinning of riparian areas in the special habitat areas of Alternatives C, D, and E. Refer to Table 2.2.4 in Chapter 2 for details on thinning rules in conservation areas.

The significance of this potential effect would generally track with the total amount of marbled murrelet conservation areas to be designated under each alternative. Since implementation of the RFRS, the DNR has been commercially thinning only a small portion of the total riparian acres available with timber sales for ecological or administrative reasons. Non-commercial thinning would still be allowed in most areas, so the overall effect of this reduced ability to conduct commercial thinning within RMZs, while conceptually adverse, is not likely to significantly reduce the ability of DNR to reach aquatic resource management objectives defined in the 1997 HCP.

None of the alternatives are likely to result in adverse impacts on aquatic resources that would significantly contribute to cumulative effects of forest management activities on aquatic habitats.

Table 4.4.1. Summary of Potential Impacts to Aquatic Resources

Key questions	Criteria	Measures	Potential impacts
How would alternatives affect riparian functions, including riparian habitat, wetlands, water quality and quantity, and fish populations and habitat?	Functions of riparian and wetland habitat for wildlife and water resources are maintained (1997 HCP, *Policy for Sustainable Forests*).	Degree to which these functions are already adequately protected by the existing framework of regulations, policies, and plans. The degree to which the alternatives would change allowable forest management activities.	The existing framework of regulations, policies and plans would adequately address potential effects on aquatic resources. All action alternatives would maintain or enhance aquatic functions, with the possible exception of riparian microclimate, which could see increased impacts under Alternative B (which has less LTFC than the no action alternative).
Would marbled murrelet conservation areas or measures restrict DNR's ability to conduct active management under the HCP riparian conservation strategies to restore functioning riparian habitat?	No substantive change in ability of DNR to reach riparian strategy objectives on state trust lands.	Qualitative review of the type of restrictions in active management of riparian areas under each alternative.	Restrictions in commercial thinning within special habitat areas under Alternatives C, D and E could potentially delay some RMZs from reaching restoration objectives in these areas. This, in turn, may affect one or more of the various indictors of riparian functioning. However, these effects are not likely to significantly reduce the ability of DNR to reach aquatic resource management objectives defined in the 1997 HCP riparian conservation strategies.

4.5 Wildlife and Biodiversity

This section considers whether any of the strategies to conserve marbled murrelets could have unintended consequences to other species of wildlife, particularly federally listed species or other wildlife species that are sensitive to disturbance, have low population levels or restricted ranges, or are otherwise important for recreational, commercial, cultural, or ecological values.


DNR-managed lands in South Puget planning unit. Photo: DNR

Analysis question

- *Do areas proposed for marbled murrelet conservation under the action alternatives potentially impact federally listed species or other wildlife species?*

Evaluation criteria

This analysis considers the following criteria:

- Wildlife habitat and species diversity, and the ecological functions needed to support them within the analysis area, are maintained by the alternatives.
- Northern spotted owl habitat targets and conservation strategies are maintained by the alternatives.
- Species listed as threatened or endangered are not experiencing adverse impacts by the alternatives.

Scale of analysis

For this DEIS, wildlife habitats and biodiversity are considered in terms of trends over the entire analysis area and through the planning period (5 decades).

How impacts are measured

Impacts are measured based on the degree to which alternatives would potentially change 1997 HCP strategies for species other than the marbled murrelet or the 2006 *Policy for Sustainable Forests'* objectives. The degree to which the alternatives would affect habitat and species diversity is measured by considering species-habitat associations and trends in forest stand development stages.

Effects on regionally important species are considered based on a qualitative assessment of anticipated habitat changes (based on LTFC conditions).

Summary of direct, indirect, and cumulative impacts

Habitat and species diversity

All alternatives are expected to maintain overall wildlife habitat and species diversity across DNR-managed lands, as habitat both within and outside of LTFC would continue to be managed to improve forest productivity, wildlife habitat, and species diversity.

Silvicultural methods such as variable retention harvest and variable-density thinning will continue to create and maintain differing wildlife habitats and biodiversity within the working forest landscape (DNR 2013, p. 3.23).

Within the analysis area, overall habitat and species diversity would remain similar to that which would occur under the no action alternative. Some localized impacts to the habitat supporting some species guilds may occur, but these pose little to no risk to overall species diversity.

Text Box 4.5.1

Example of local increase in LTFC under Alternative F (indicated by magenta) north of U.S. Highway 2, North Puget planning unit.

Under Alternative F, lands currently mapped as low-quality northern spotted owl habitat would be included as additional LTFC (Alternatives A through E only include high-quality owl habitat as LTFC). This could change the way forests develop in these areas as low-quality owl habitat matures into more structurally complex forest. HCP habitat targets are still expected to be met in these areas.

Under all alternatives other than Alternative F, low-quality owl habitat would continue to be managed according to HCP thresholds.

INCREASE IN LTFC AND STRUCTURALLY COMPLEX FORESTS

All alternatives except Alternatives A and B would result in a net increase in LTFC on DNR-managed lands. Alternative A reflects current practices and does not increase LTFC, but Alternative B decreases LTFC from current conditions. A small increase in structurally complex forests and associated wildlife diversity would be expected over time under these alternatives, accompanied by a corresponding decrease in ecosystem initiation stage forests and associated wildlife communities.

Alternatives C, D, and E would result in larger but very similar amounts of LTFC, adding between 14,000 and 20,000 acres compared with the no action alternative. This amount of change may have local effects on wildlife habitats within special habitat areas and emphasis areas, where most additional LTFC would be established. The wildlife guild associated with ecosystem initiation stages could be locally affected as those forests enter the competitive exclusion stage, which supports fewer species. Wildlife guilds associated with more structurally complex forests would benefit as forests mature over time.

REDUCTION IN EARLY STAGE FORESTS AND ASSOCIATED WILDLIFE

Lands outside of LTFC can be harvested, providing ecosystem initiation stage forests. Within LTFC, areas available for harvest are reduced under all action alternatives except Alternative B. Alternative F would result in the greatest increase in LTFC compared with the other alternatives, with an approximate increase of 18 percent (114,000 acres) in LTFC compared with Alternative A.

INCREASED PATCH SIZE/DECREASED EDGE

As illustrated in Section 4.6, Marbled Murrelets, all of the alternatives except Alternative B would result in an increase in “interior” forest habitats, which for this DEIS are defined as LTFC areas that are at least 100 meters from any edges with actively managed forest. This increase in interior habitat is expected to improve habitat for interior guild species. Increases range from 21 percent under Alternative A to 67 percent under Alternative F.

Increases in interior habitat will result in localized reductions of edge-associated species. However, all alternatives would maintain a majority of LTFC within stringer and edge configurations. Therefore, impacts to edge habitats and associated wildlife guilds and species diversity are not expected to be significant.

REDUCED DISTURBANCE AND FOREST MANAGEMENT ACTIVITIES

All alternatives would reduce disturbance during the murrelet nesting season, which would likely benefit other species of wildlife that breed during the same periods. Proposed conservation measures under the action alternatives would also result in changes to road management, with most new road building likely to occur outside marbled murrelet conservation areas.

Sensitive and regionally important wildlife

None of the alternatives are likely to affect populations of species listed in Appendix L at the scale of the analysis area. Species associated with ecosystem initiation forests may experience some local declines under Alternatives C, D, E, and F.

All of these changes would potentially increase breeding and resting/hiding habitat for several sensitive species while at the same time reducing foraging habitats. However, these effects would be noticeable for the most part only at the local level, primarily within designated special habitat areas, emphasis areas, and marbled murrelet management areas. In the larger analysis context of the 1.377 million acres of DNR-managed lands, populations and distribution of sensitive species on DNR-managed lands would be maintained.

GAME SPECIES

Black bears often select structurally complex forests for denning. Therefore, bear populations may benefit from additional denning habitat provided by forest stands managed to develop marbled murrelet nesting habitat under all alternatives. However, it is unlikely that additional den habitat would significantly increase bear populations, as other factors such as hunting pressure, food availability, and density-dependent competition are also important factors in keeping bear populations in check.

Increasing LTFC—as would occur under Alternatives C, D, E, and F—would increase structurally complex forest over time. These forests are likely to provide cover habitat for deer and elk. (Cover habitat is used for protection from predators and inclement weather.) Proportional decreases in timber harvest activities could decrease foraging habitat in some areas (reducing the amount of forest in the ecosystem initiation stage), but this decrease is not expected to be significant at the scale of the analysis area. No alternative is expected to have negative effects to deer or elk.

Text Box 4.5.2

How will elk habitat be affected?

Elk feed in cleared areas but seek cover in forested areas. The proposed alternatives would generally increase cover habitat while decreasing foraging habitat. This effect would be in proportion to the amount of additional LTFC to be designated under each alternative. While foraging habitat may decrease locally in certain areas (particularly under Alternative F), this decrease is not expected to be sufficient in scale to reduce overall health, population growth, or distribution of elk herds.

Photo: WDFW

BIRDS

Likewise, forest owls may benefit from LTFC designation, although reduced edge habitat may result in local reductions in foraging habitats. Similarly, edge-associated species including red-tailed and sharp-shinned hawks and great horned owls could potentially decline locally where additional LTFC is designated. Finally, the alternatives would have mixed and primarily localized effects on neo-tropical migratory birds, with a moderate increase in species associated with structurally complex and interior forests (for example, Townsend's warbler) and moderate decreases in species associated with ecosystem initiation stage forests (for example, willow flycatcher). However, similar to other species discussed, there would be no significant impacts at the scale of the analysis area (1.377 million acres of DNR-managed lands).

Table 4.5.1. ESA-Listed Species and Potential for Adverse Impacts

Species	Federal status	Potential for adverse impacts from marbled murrelet conservation alternatives
Columbian white-tailed deer (*Odocoileus virginianus leucurus*)	E	None. Habitats associated with the Columbian white-tailed deer are protected by the 1997 HCP riparian and wetland strategies. This species is peripheral to DNR-managed forestlands.
Gray wolf (*Canis lupus*)	E	None. Habitats associated with the gray wolf are protected by the HCP gray wolf conservation efforts.
Grizzly bear (*Ursus arctos horribilis*)	T	None. The combination of 1997 HCP riparian, wetland, and uncommon habitats and northern spotted owl conservation strategies protects grizzly bear habitat. This species is a rare occurrence on DNR-managed forestlands.
Mazama pocket gopher (*Thomomys mazama subspecies*)	T	None. Mazama pocket gophers occupy prairie-like habitat—areas that are relatively open, with short-statured vegetation and few woody plants. This type of habitat and this species is peripheral to DNR-managed forestlands.
Northern spotted owl (*Strix occidentalis caurina*)	T	None. Habitats associated with the northern spotted owl are protected by the1997 HCP northern spotted owl strategy.
Oregon silverspot butterfly (*Speyeria zerene hippolyta*)	T	None. Habitats associated with the Oregon silverspot butterfly are protected by the 1997 HCP Oregon silverspot butterfly conservation efforts. This species is peripheral to DNR-managed forestlands.
Oregon spotted frog (*Rana pretiosa*)	T	None. Habitats associated with the Oregon spotted frog are protected by the 1997 HCP riparian and wetland strategies.
Snowy plover (*Charadrius alexandrinus nivosus*)	T	None. Snowy plovers nest primarily on coastal beaches, dunes, and beaches at creek and river mouths. These habitats are protected with the 1997 HCP riparian and wetland strategies. This species is peripheral to DNR-managed forestlands.
Streaked horned lark (*Eremophila alpestris strigata*)	T	None. Streaked horned larks nest on the ground in sparsely vegetated sites dominated by grasses and forbs and occasionally on beaches or estuaries. Where these habitats occur near DNR-managed lands, they are protected with the 1997 HCP riparian and wetland strategies. This species is peripheral to DNR-managed forestlands.
Taylor's checkerspot butterfly (*Euphydryas editha taylori*)	E	None. Habitats (primarily balds and open grasslands) associated with the Taylor's checkerspot butterfly are protected by the 1997 HCP uncommon habitats strategy.
Western yellow-billed cuckoo (*Coccyzus americanus*)	T	None. Habitats associated with the western yellow-billed cuckoo are protected by the 1997 HCP riparian and wetland strategies.

Northern spotted owl

There are no changes proposed to the northern spotted owl goals and objectives. The designated nesting, roosting, and foraging (NRF) and dispersal areas will not change in location or habitat targets. The DNR will continue to manage for achievement of 1997 HCP habitat thresholds within these areas as well as within each of the landscapes in the OESF. Alternative F, though, differs in that it will treat mapped, low-quality northern spotted owl habitat as LTFC (47,000 acres) within the designated NRF and dispersal areas and within each of the landscapes in the OESF (refer to Text Box 4.5.1 as an example).[4] In this LTFC designation, the DNR will still be able to perform silvicultural treatments—such as variable density thinning—to enhance future spotted owl and marbled murrelet habitat. Because many NRF and dispersal management areas are currently below their habitat target, this addition of LTFC is not expected to change the general management approach over what would otherwise occur. In addition, LTFC designated outside current spotted owl management areas, for example in the Straits and South Coast planning units, would provide additional blocks of potential owl habitat.

Inclusion of spotted owl habitat in LTFC will not have a direct, negative effect on spotted owl habitat. Stands that provide habitat will continue to do so. Likewise, stands that do not yet provide spotted owl habitat but are naturally developing toward habitat conditions will continue to do so, providing benefits to the spotted owl.

Silvicultural treatments in designated owl conservation areas (NRF, dispersal, and OESF) will continue according to the HCP strategies except where special habitat areas overlap these areas because commercial thinning is not allowed in special habitat areas.

[4] Low-quality northern spotted owl habitat is the same as Young Forest Habitat in the OESF.

Table 4.5.4. Summary of Potential Impacts to Wildlife

Key questions	Criteria	Measures	Potential impacts
Do areas proposed for marbled murrelet conservation under the alternatives potentially impact federally listed species or other wildlife species?	1997 HCP conservation objectives Habitat diversity is not lost. Both ecosystem initiation and structurally complex stand development stages (the two stages used most by wildlife) are available in sufficient quantities to support associated species within the analysis area. An adequate mix of habitat types is maintained under the alternatives, including early seral-stage forests and edge habitats, to support wildlife diversity Landscapes are not dominated by competitive exclusion stage forests with low wildlife diversity.	Total LTFC Acres of marbled murrelet conservation overlapping spotted owl conservation Acres of interior forest; Acres of edge forest Acres of DNR-managed lands affected (for context and scale of effects)	None/beneficial Wildlife diversity is likely to increase over time with all alternatives. Some local losses of diversity associated with fewer acres of ecosystem initiation stage stands, particularly under Alternative F. However, at the scale of the analysis area, such habitats would remain sufficiently abundant to maintain biodiversity on DNR-managed lands. Localized changes in habitat conditions may temporarily affect some sensitive species, but overall amount of habitat available for sensitive species would remain stable or increase on DNR-managed lands. Foraging habitat for deer and elk may be locally reduced where larger blocks of LTFC would be added. This is primarily true of Alternative F. However, foraging habitat would continue to be present at the scale of the analysis area.

4.6 Marbled Murrelet

This section describes the potential effects of the alternatives on marbled murrelet nesting habitat and population.

Analysis questions

- *How do the alternatives affect marbled murrelet nesting habitat, and how are changes to nesting habitat quantity and quality expected to affect the marbled murrelet population?*
- *Do the alternatives provide habitat in important geographic locations for marbled murrelet conservation? These include southwest Washington and areas close to marine waters, including along the Strait of Juan de Fuca and in the North Puget planning unit.*

Evaluation criteria

As described in Section 3.6, both the marine and inland habitats of the marbled murrelet play key roles in the life cycle of the species. The proposal addresses management activities on forested state trust lands, not the marine environment, and therefore no impacts are anticipated to the marine environment. This analysis will focus on how inland nesting habitat is affected by the alternatives and whether anticipated changes to that habitat will impact the marbled murrelet population.

Scale of analysis

This analysis considers all DNR-managed lands within the analysis area, with data summarized at the HCP planning-unit level where important for comparisons among the alternatives. Comparative marbled murrelet habitat and population data from other conservation zones (refer to Section 3.6) is also considered in order to understand relative impacts of the alternatives.

How impacts are measured

The analysis will consider:

- Habitat quantity, including anticipated loss of potential habitat and gains in habitat through the life of the HCP
- Habitat quality, including P-stage and edge effects
- Disturbance impacts to habitat from forest use and management activities
- Amount and quality of habitat in geographically important areas
- Potential impacts to the marbled murrelet population in Washington using a population viability analysis model

Summary of direct, indirect, and cumulative impacts

As a forest manager, DNR's activities cause direct and indirect impacts to marbled murrelets. Timber harvest and thinning can remove current or potential future habitat and increase deleterious edge effects at nearby habitat. Roads and trails built for access to and through DNR-managed lands can cause direct impacts by removing habitat and also increase disturbance effects by creating forest edges. Other disturbance effects including audio-visual disturbance, predator attraction, and impulsive noise can cause both direct and indirect impacts to nesting birds. Cumulatively, these impacts can result in reduced habitat quantity and quality. The alternatives propose to conserve existing habitat and add new habitat areas to existing conserved forestlands, which will result in new and higher-quality habitat developing over time.

This section compares the relative impacts of the action alternatives and how these impacts ultimately affect the marbled murrelet populations.

Direct impacts: Habitat loss and gain

Ongoing forest management within the analysis area, outside of marbled murrelet-specific conservation areas, will result in short-term losses to mostly low-quality potential habitat, followed by long-term gains in both low- and high-quality habitat within LTFC.

PROTECTION OF OCCUPIED SITES

All of the alternatives protect occupied sites, which are patches of habitat where evidence of marbled murrelet use has been observed. The action alternatives assume site occupancy based on the occupied sites identified in the Science Team Report, resulting in approximately 16,000 more acres of occupied sites than would be assumed under the no action alternative. Timber harvest would be prohibited in these areas, as would most of the forest management and land use activities known to disturb nesting marbled murrelets. However, there will be isolated cases where some limited forest management activities may occur within an occupied site, such as a road construction or individual tree removal. All alternatives except Alternative B add buffers to these occupied sites. Alternatives C through F use special habitat areas, emphasis areas, or MMMAs that would further increase the security habitat around some occupied sites in strategic locations.

Table 4.6.1. Comparison of Occupied Site Protection Strategies Among Alternatives

Occupied site protection	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Increase acres of occupied sites	No	Yes	Yes	Yes	Yes	Yes
Applies occupied site buffers	Yes	No	Yes	Yes	Yes	Yes
Additional security acres for occupied sites	No	No	Yes—special habitat areas and emphasis areas	Yes—special habitat areas	Yes—special habitat areas and emphasis areas	Yes—MMMAs
Applies conservation measures to protect occupied sites from disturbance	No	Yes	Yes	Yes	Yes	Yes

The use of buffers and other protective measures to occupied sites reduces the risk to marbled murrelet habitat from predation and other disturbances. Since marbled murrelets frequently re-use their nesting areas (Nelson 1997), enhancing the protection of occupied sites is a strategy that would likely reduce the risk of birds having to move nest locations.

POTENTIAL HABITAT LOSS FROM HARVEST

Outside of long-term forest cover, some P-stage habitat for the marbled murrelet will be harvested under the proposed action. As a “reasonable worst case” scenario, the analysis assumed that all harvest of this habitat would occur in the first decade of the planning period. For analysis, habitat is described as either low quality (P-stage value 0.25–0.36) or high quality (P-stage value 0.47–0.89). Table 4.6.2 estimates the acres of low-quality and high-quality P-stage habitat that will be harvested in the first decade, outside of long-term forest cover.

Table 4.6.2. Estimated Acres of Habitat Released for Harvest in Analysis Area

	HCP Unit	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Low-quality P-stage habitat loss to harvest (P-stage value 0.25–0.36)	OESF	6,104	8,532	6,363	7,486	6,123	3,398
	Straits	3,503	5,407	4,880	4,439	4,438	4,881
	North Puget	12,990	13,564	12,717	12,488	12,316	8,823
	South Puget and Yakima	3,997	4,250	4,212	4,214	4,212	1,569
	Columbia	2,921	4,963	3,103	3,103	3,103	1,086
	South Coast	1,920	4,102	3,333	3,332	3,333	2,660
Subtotal		31,435	40,818	34,608	35,062	33,525	22,417
High-quality P-stage habitat loss to harvest (P-stage value 0.47–0.89)	OESF	2,007	4,472	0	3,779	0	945
	Straits	579	751	0	488	0	667
	North Puget	1,417	1,804	0	1,556	0	789
	South Puget and Yakima	948	1,180	0	1,124	0	495
	Columbia	40	233	0	94	0	70
	South Coast	15	173	0	164	0	57
Subtotal		5,006	8,613	0	7,205	0	3,023
Total acres		**36,441**	**49,431**	**34,608**	**42,267**	**33,525**	**25,440**

Most harvest outside of LTFC in the first decade is expected to be in low-quality habitat. Of the total habitat taken under each alternative, 83–100 percent is low quality. The most overall harvest is under Alternative B. Differences in where marbled murrelet conservation areas have been proposed result in the no high-quality habitat being removed under Alternatives C and E.

POTENTIAL HABITAT GAINS

Throughout LTFC, P-stage habitat will increase in amount and quality over time. This habitat gain would occur under the no action alternative as the interim strategy continues to be implemented. By the final decades of the HCP, initial habitat loss outside LTFC will be outpaced by gains in habitat within LTFC, where the regulatory framework exists to maintain these forests in long-term forest cover. Gains are expected under every alternative (refer to Table 4.6.3 and Figure 4.6.1).

Table 4.6.3 Estimated Acres of Habitat in the Final Decade of the Planning Period in LTFC, by HCP Planning Unit and Alternative

	HCP Unit	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Final decade potential low-quality P-stage habitat	OESF	3,322	3,154	3,375	3,168	3,375	3,458
	Straits	25,368	19,991	21,274	21,754	21,755	21,273
	North Puget	49,008	48,423	49,737	49,727	49,998	58,820
	South Puget and Yakima	31,383	31,168	31,240	31,237	31,240	40,543
	Columbia	7,840	7,729	8,763	8,763	8,763	8,818
	South Coast	31,742	31,286	31,572	31,572	31,572	32,234
Total low-quality habitat		**148,662**	**141,750**	**145,962**	**146,221**	**146,703**	**165,145**
Final decade potential high-quality P-stage habitat	OESF	63,694	58,893	65,974	60,857	66,284	69,084
	Straits	8,484	9,032	10,020	9,955	10,458	9,337
	North Puget	69,175	68,137	70,980	69,432	71,283	76,929
	South Puget and Yakima	11,073	10,632	11,902	10,761	11,902	14,662
	Columbia	11,772	9,337	11,860	11,762	11,860	14,070
	South Coast	20,824	18,869	21,372	20,823	21,372	22,434
Total high-quality habitat		**185,021**	**174,900**	**192,109**	**183,590**	**193,158**	**206,516**
Combined totals		**333,684**	**316,650**	**338,071**	**329,811**	**339,861**	**371,661**

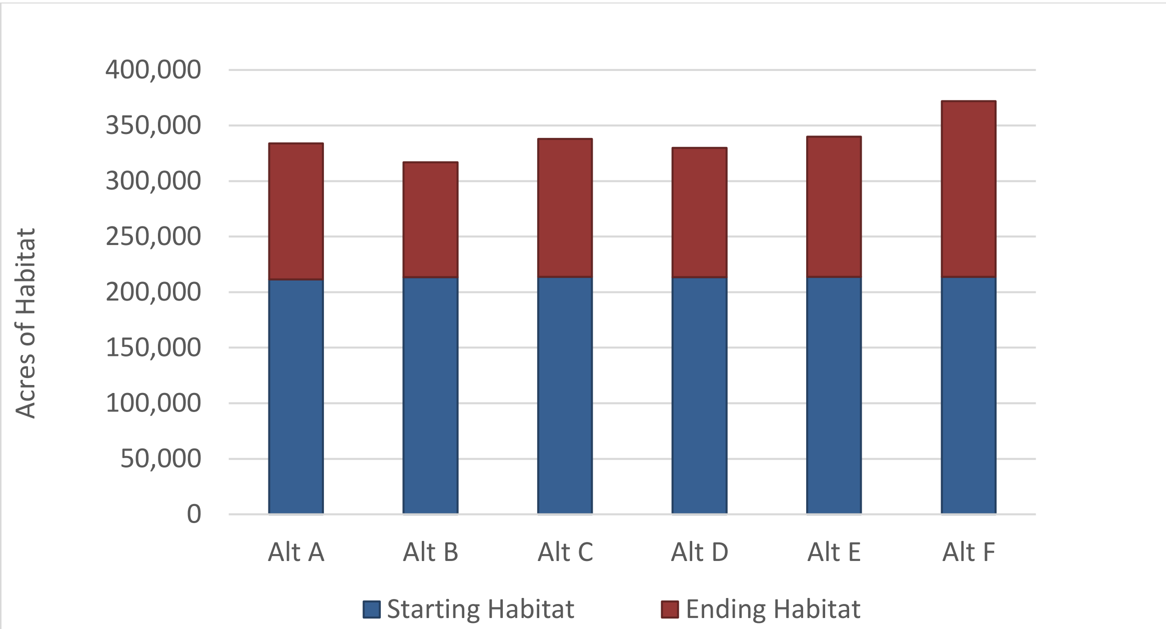
Focus on Southwest Washington

USFWS has identified DNR-managed lands in southwest Washington as important for marbled murrelet recovery because of the lack of federal lands in this landscape to provide for marbled murrelet conservation (USFWS 1997). Much of the existing nesting habitat and most known marbled murrelet occupied sites in southwest Washington are located on DNR-managed lands. The South Coast and Columbia HCP planning units cover this area. The Joint Agencies have identified a range of conservation options for these lands to maintain and improve the distribution of murrelet habitat in this important landscape. The no action alternative would protect approximately 81 percent of all known P-stage habitat in South Coast and 59 percent in Columbia. Alternatives C through E would protect more of this habitat, approximately 85 percent in South Coast and 75 percent in Columbia. Alternative F protects the most P-stage habitat, protecting approximately 85 percent in South Coast and 91 percent in Columbia, while Alternative B protects less: 65 percent in South Coast and 34 percent in Columbia (significantly less than the no action alternative).

NET HABITAT BY END OF PLANNING PERIOD

Effects of the proposed harvest of 25,000 to 49,000 acres of habitat outside LTFC during the first decade, coupled with predicted habitat development in LTFC during the 5-decade planning period, result in a net increase of habitat acreage for every alternative, including the no action alternative (Alternative A) (Refer to Figure 4.6.1).

Figure 4.6.1. Growth of Habitat Through Time, by Alternative



Acres not adjusted for quality; includes stringers.

Accounting for habitat quality

Although every alternative shows a net gain of habitat acres through the life of the HCP, the *quality* of this habitat is influenced primarily by P-stage and edge effects. Other factors, including whether the habitat is in an interior forest condition, the geographic location of habitat, and the timing of habitat development also factor into overall habitat quality.

P-STAGE AND HABITAT QUALITY

Acres of habitat lost or gained are modified by their P-stage values, which reflects the quality of that habitat based on its probability to be used for nesting (refer to Appendix F). An acre of the lowest quality habitat (P-stage value 0.25) is therefore "worth" only 0.25 acres in terms of its habitat quality. Multiplying the acres of habitat projected to grow within the planning period by their P-stage value creates a more accurate picture of the mitigation value of these acres as compared with the non-adjusted acres reported in the previous section. Both adjusted and non-adjusted acres are reported in this analysis for purposes of comparing the alternatives. P-stage is combined with other adjustment factors (refer to the following section).

INTERIOR FOREST HABITAT

Larger patches of interior forest located away from forest edges are more likely to help protect nesting marbled murrelets from the effects of predation, changes to microclimate, and other types of disturbance events and activities. Interior forest is not subject to edge effects. Chapter 2 provided summary data on the relative interior and edge conditions expected in long-term forest cover under each alternatives. This section further analyzes the differences among the alternatives relative to the protection and development of interior forest habitat.

Patterns of habitat development differ by alternative within HCP planning units and among planning units. After initial harvest of habitat in the first decade of the planning period, new habitat is expected to grow and develop. Development of habitat in areas of interior forest may be the most important for developing functional nesting habitat for the marbled murrelet over time. For example, Alternatives C, D, and E, include 100-meter buffers around all occupied sites, which will effectively increase the area of interior habitat associated with the occupied sites and minimize potential for edge effects in occupied sites from future management. Figure 4.6.2 shows how interior forest habitat is expected to develop.

Figure 4.6.2. Estimated Growth of Interior Forest Habitat Among HCP Planning Units

Alternatives C through F, all of which variously incorporate marbled murrelet conservation areas beyond existing occupied sites, provide greater proportions of interior habitat than Alternative B. Alternatives C through F also present a variety of approaches to reduce edge effects on murrelet habitat by strategically configuring some areas of LTFC and result in a somewhat greater proportion of interior habitat than Alternative A, the no action alternative.

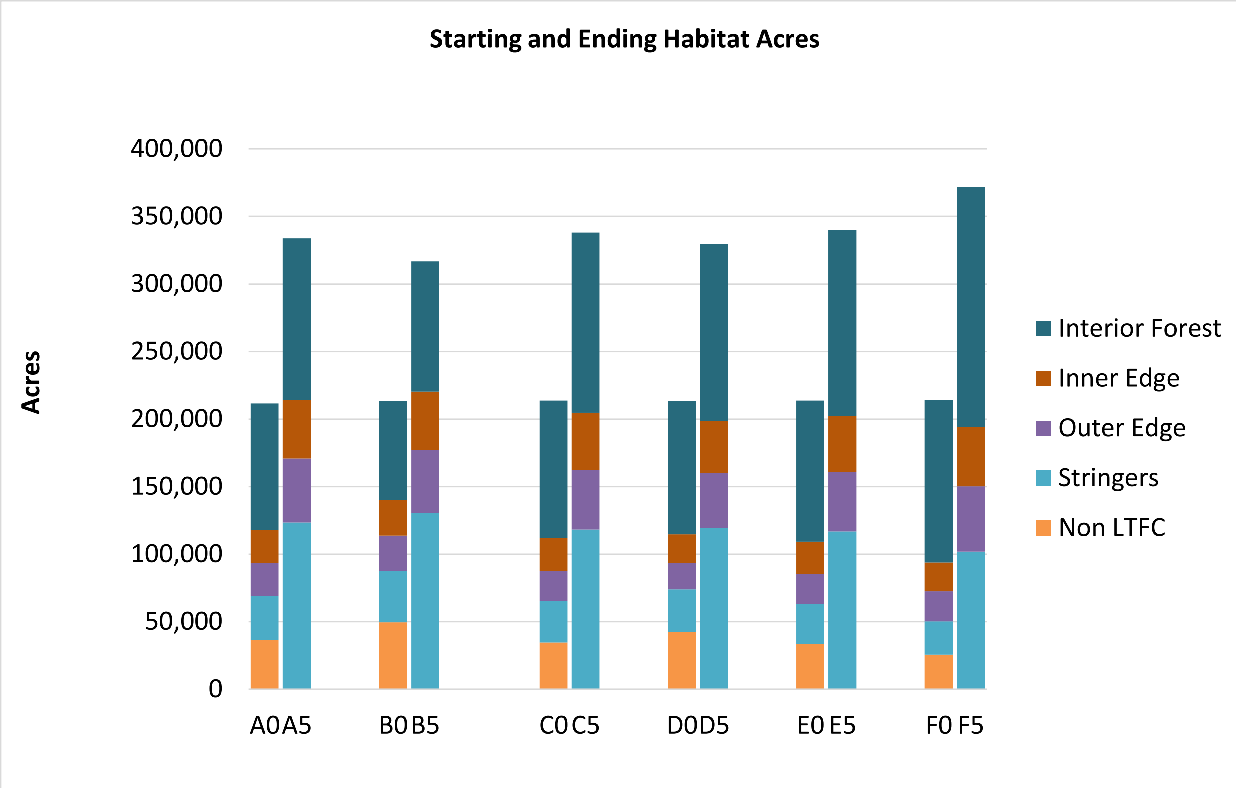
In the short term, loss of mostly low-quality habitat outside of long-term forest cover will occur under any alternative, including the no action alternative. This habitat loss is not in areas of known nest sites or occupied habitat. Within the first 2 decades, growth of new habitat and development of higher-quality habitat outpaces this initial habitat loss.

EDGE EFFECTS

Habitat that is not in interior forest is considered edge habitat (including habitat located in stringers). Habitat in an edge condition is subjected to a number of edge effects, including changes to microclimate, increased risk of predation, increased windthrow, and other types of disturbances (refer to Section 3.6 and Appendix I). Because the amount and composition of marbled murrelet-specific conservation areas differs among alternatives, there are different amounts of edge habitat.

Figure 4.6.3 compares the acres of habitat in different interior and edge conditions based on current (Decade 0) conditions versus projected edge conditions for all alternatives at the end of the planning period (Decade 5). Stringer habitat is also presented (refer to Figure 4.6.3).

Figure 4.6.3. Starting (Decade 0) and Ending (Decade 5) Habitat, by Alternative and Edge Position



Acres not adjusted for quality. "Non-LTFC" refers to P-stage habitat outside LTFC.

Under all alternatives, existing edges within long-term forest cover soften and disappear over time as younger forests within LTFC mature. Limitations on timber harvest and related activities (such as road construction) mean that the creation of new edges in habitat will also diminish significantly through time in LTFC under all alternatives.

Roads

While existing forest edges in LTFC will soften and abate over time as forests mature, many roads through LTFC will be maintained under all alternatives because they are part of a greater transportation network. These roads will have chronic edge effects on habitat in LTFC. The additional negative edge impacts of roads are anticipated to have minor impacts in overall habitat quality. Roads in habitat are assumed to create negative edge effects on habitat but to a lesser degree than caused by adjacent harvested and replanted stands. About 5 percent of habitat is estimated to be affected by road edges through the planning period.

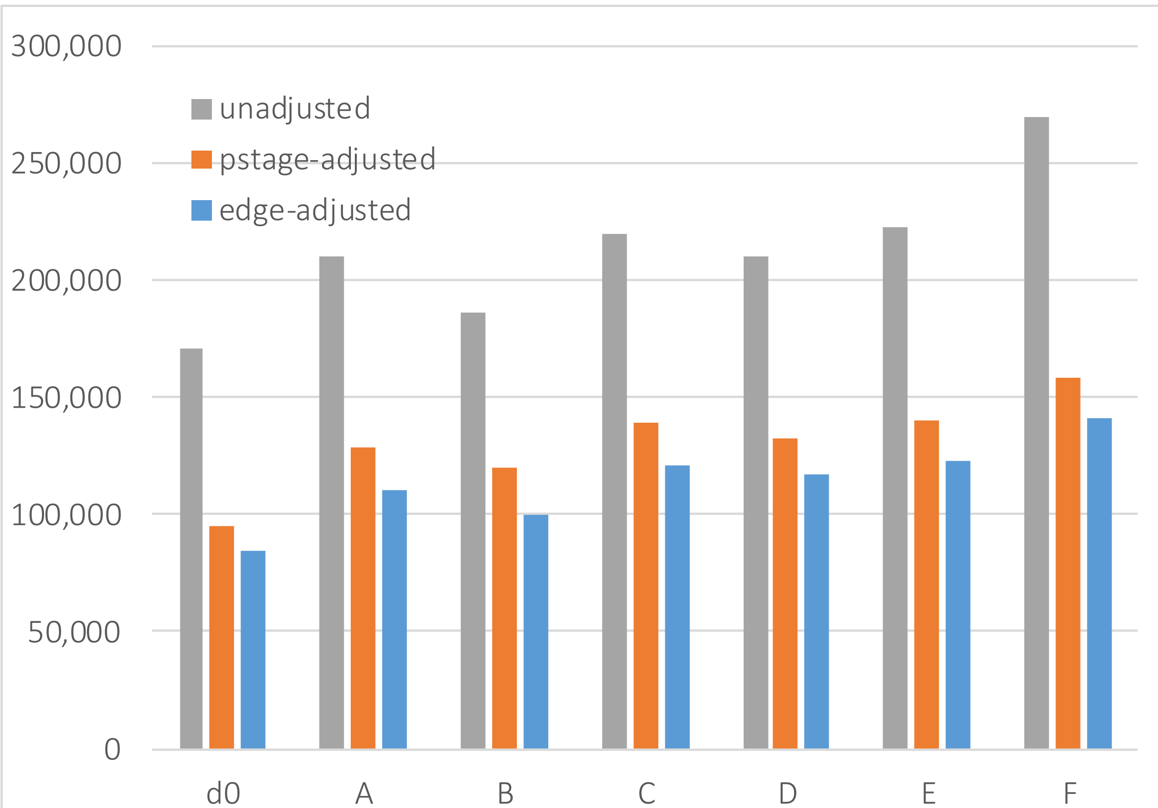
Stringers

All alternatives also project a relatively high amount of potential habitat in a stringer condition. These habitat stringers are primarily managed for riparian conservation and will never develop interior habitat because of their configuration. While habitat in stringers may provide some isolated nesting opportunities, they are assumed to have no value as nesting habitat in this analysis. Therefore, habitat located in stringers is excluded for the purposes of calculating impacts and mitigation.

HOW P-STAGE AND EDGE INFLUENCE HABITAT QUALITY

Stand-level habitat quality (P-stage) has a significantly greater effect on habitat quality than edge conditions. Figure 4.6.4 compares the gains in larger blocks of habitat (i.e., excluding stringers) as adjusted for P-stage value alone (by multiplying the habitat acreage by its P-stage value) and then further adjusted for edge condition. In Decade 5, the average P-stage-adjusted acreage is 62 percent of the average unadjusted habitat acreage, while edge adjustments further reduce that to 54 percent (Figure 4.6.4). While edge effects will negatively impact habitat quality in all alternatives, there is little difference in the level of edge influence among Alternatives C through F.

Figure 4.6.4. Comparing the Influence of P-stage and Edge Effects: Current (Decade 0) Murrelet Habitat Across all DNR-Managed Lands (Excluding Stringers) Compared With Estimated Future (Decade 5) Murrelet Habitat, by Alternative



HOW LOCATION INFLUENCES HABITAT QUALITY

Another factor influencing habitat quality among the alternatives is geographic location. The action alternatives place proportionately less habitat conservation in South Puget and portions of other planning units where distance from high-quality marine habitat and extensive development limits the marbled murrelet conservation potential of state forests. Conversely, proportionately more conservation is proposed for the OESF, Straits, and South Coast planning units, where the highest levels of marbled murrelet use of state forests occur. For example, some areas of OESF are in close proximity to important marine foraging areas such as the Strait of Juan de Fuca. Intermediate levels of conservation occur in the Columbia and North Puget planning units, with emphasis on conservation in areas closest to marine waters.

Certain geographically discrete areas of DNR-managed forests provide only marginal value for murrelet conservation because they are further than 3.1 miles (5 kilometers) from occupied sites and occur in areas with little habitat (refer to Appendix H, Figure 7). Within these "marginal landscapes," habitat value is further reduced to 25 percent of its value based on P-stage and edge effects. Effectively, none of the current or potential future habitat in North Puget, OESF, and Straits occurs in marginal landscapes, but approximately 10 and 12 percent of habitat is expected to be located within the marginal landscape in the South Coast and South Puget planning units, respectively, by Decade 5.

TIMING OF HABITAT LOSS AND DEVELOPMENT

Habitat that exists today currently provides nesting opportunities to murrelets and is therefore more valuable than habitat that will be developed further into the future (as forests mature). If an impact to that habitat happens today, the offsetting mitigation (the same value of habitat becoming available to the murrelet) may not happen for several decades. The analytical framework takes this into account by adjusting the value of mitigation through time, which is expressed by decade to the end of the HCP.

The decadal adjustment factor is based on how much habitat develops in a particular decade, as well as which decade that habitat is realized. For example, the total habitat that develops in long-term forest cover from the present into the first decade receives full mitigation credit to offset harvest in the managed forest within that first decade; all of the acres are counted. However, the total habitat that develops between the first and second decades receives only 80 percent of the total credit. This is because the habitat that grows during this decade will contribute to murrelet conservation for less time in 4 out of the 5 total decades (80 percent of decades). Growth occurring between the second and third decades receives 60 percent credit (3 out of 5 decades of growth), and mitigation credits are calculated in this way through the end of the HCP (refer to Appendix I).

Putting it all together: Quality of habitat gained and lost through time

The overall losses and gains in habitat quantity can be modified by all of the factors affecting habitat quality as listed previously: P-stage, edge, location, and the timing of the growth of new habitat. These factors are described in further detail in Appendix H. Habitat with little value (stringers) is excluded outright, and habitat in edge condition or located far from at-sea populations or occupied sites are assumed to have a reduced quality.

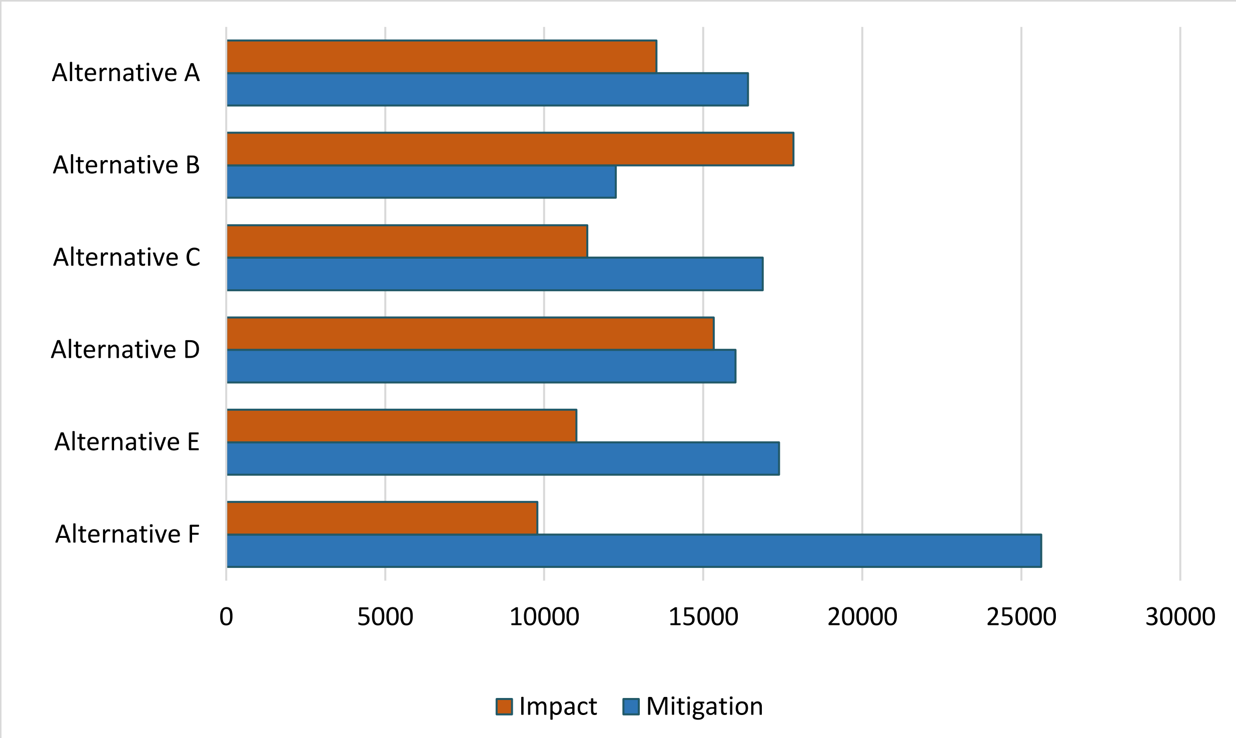
The result of these modifications can be reflected as a comparison of “impact” (habitat loss) to “mitigation” (habitat gain). As shown in Figure 4.6.5, Alternative F has the highest ratio of mitigation to impact at around 2.5:1. Alternatives A, C, and E all show significantly more acres gained than lost over the planning period, while Alternative D shows only slightly more gain than loss. Only Alternative B results in impact exceeding mitigation.

Under every action alternative, mitigation credit is assigned to marbled murrelet habitat that currently exists or develops within LTFC through the life of the HCP. Mitigation acres can be estimated and compared against potential impacts, which is the loss of P-stage habitat outside LTFC. Appendix I provides a detailed description of how the Joint Agencies will estimate potential impact and mitigation acres under the proposed action.

It is important to recognize that while specific outcomes are presented, in this case in impact and mitigation acres, there are uncertainties associated with these estimates. These uncertainties include the realization that habitat selection by marbled murrelets is complex and poorly understood and that forest growth and future habitat development may be influenced by many factors (such as climate change or natural disturbance) as described in Appendix E. The projections of future habitat development presented here are estimates which may or may not be realized over time. In addition, there are potential impacts to the species that are not clearly understood. Debate remains in the scientific community on how certain impacts (such as noise disturbance) may or may not affect the species.

The Joint Agencies worked together on developing the P-stage model and the analytical framework for the purposes of developing and analyzing the alternatives. These models serve as a tool to facilitate our relative understanding of impacts and mitigation for the different alternatives. The population model is also relevant for further interpretation of potential impacts. A summary of impacts (e.g., mostly habitat loss) and mitigation acres (habitat development over time) as measured by adjusted acres expected under each alternative is provided in Figure 4.6.5.

Figure 4.6.5. Adjusted Acres of Habitat Loss (Impact) and Gain (Mitigation) by the End of the Planning Period, by Alternative and Adjusted for Quality



Gains and losses are not equally distributed among HCP planning units. Table 4.6.4 shows the net acres in each HCP planning unit when adjustments are made for habitat quality (P-stage, edge effects, and time).

Table 4.6.4. Acres of Mitigation Minus Impact, by HCP Planning Unit and Alternative

	Mitigation minus impact (quality- and time-adjusted acres)					
HCP unit	**Alt. A (no action)**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. F**
OESF	-37	-3,926	387	-2,801	554	1,616
Straits	48	-1,151	-395	-277	22	-809
North Puget	1,146	536	2,531	1,618	2,799	6,868
South Puget and Yakima	-30	-283	369	-199	369	3,234
Columbia	-70	-1,317	408	473	408	1,810
South Coast	1,185	285	1,529	1,343	1,529	3,402
Total (net)	**2,242**	**-5,856**	**4,829**	**157**	**5,681**	**16,121**

Positive values occur where mitigation exceeds impact, negative values where impact exceeds mitigation.

Changes in acres are strongly related to the condition of these planning units at the beginning of the planning period. North Puget begins the planning period with a greater inventory of low-quality habitat and older non-habitat and therefore shows a significant increase in habitat quality through time. For planning units that begin with a relatively high proportion of protected, high-quality habitat (including OESF and Straits), negative acres can result for alternatives that shift the conservation focus from these areas to other HCP planning units. North Puget and the South Coast, where conserved high-quality habitat is currently scarce, show gains in habitat under any alternative.

Effect on marbled murrelet populations

The preceding analysis measures the amount and quality of habitat conserved or developed over the planning period. However, the amount and timing of habitat loss and development may not directly relate to population growth or decline. Uncertainties about marbled murrelet survival, reproduction rates, dispersal, and other environmental influences may affect how the population responds to increased habitat.

To help understand how marbled murrelet populations might respond to the variations in habitat presented in each alternative, the Joint Agencies engaged Dr. Zach Peery of the University of Wisconsin, an expert population ecologist and marbled murrelet biologist, to develop a model that could estimate the effects of the alternatives on marbled murrelet populations and incorporate the habitat estimates and analytical framework described in preceding sections and in supporting documents.

Dr. Peery’s team built a population viability analysis model to compare the effects of the alternative proposals for habitat harvest and development on the marbled murrelet population in Washington. The model used demographic information obtained in intensive field studies and available in published reports. It was based on reasonable understanding and interpretation of murrelet ecology and nesting habitat relationships as well as detailed assessments of forest conditions in Washington, especially on DNR-managed lands.

As is common in population viability analyses, a number of simplifying assumptions regarding murrelet demography, dispersal, and breeding biology were required. Also in common with most population viability analyses, model predictions of risk and population size are best viewed in a relative sense. The uncertainties underlying the model do not support absolute predictions of ending population size (for example, the exact number of murrelets at a given point in time). Instead, the model outputs are best used as relative comparisons of risk and potential for recovery among the management alternatives. Model predictions must be considered in light of uncertainty about the effects of stressors in the marine environment and future changes in climate as too little is known about these non-forest influences to incorporate them into the model structure. For a detailed presentation of modeling methods, results, and discussion, including assumptions and limitations, refer to Appendix C.

Two different scenarios encompass the principal hypotheses regarding uncertainty over the environmental factors that influence the murrelet population decline. A “risk analysis” scenario was based on the assumption that both nesting habitat loss and other chronic environmental stressors such as marine conditions are responsible for the murrelet population decline observed in Washington. It used relatively pessimistic demographic rates that result in a declining murrelet population with less ability to use nesting habitat as it develops. An "enhancement analysis" assumed that loss of nesting habitat is primarily responsible for the population decline and uses more optimistic demographic rates that result in a murrelet population with greater capacity to use nesting habitat as it develops.

To focus on relative differences between the alternatives, murrelets in Washington were assumed to belong to two simplified subpopulations (DNR and non-DNR), with habitat conditions artificially held constant on non-DNR lands. Simulations of the Washington population assumed that the two subpopulations were connected by dispersal while simulations of the DNR population alone assumed no dispersal. The models simulated murrelet populations over 50 years in response to the current and projected future habitat conditions proposed under each alternative. All simulations begin with a population assumed to be approximately 40 percent greater than the carrying capacity (*K*) of existing habitat in order to simulate the observed rate of decline. Researchers conducted 10,000 simulations with biologically appropriate levels of random variation in survival and reproductive rates for each alternative to produce two informative outputs: average ending population size and the proportion of model runs that fell below specified fractions of the initial population size as a measure of "quasi-extinction risk."

Detailed results can be found in the report (Peery and Jones 2016, Appendix C); results are briefly summarized here.

RISK ANALYSIS

When the Washington population was evaluated, few differences could be seen in projected population size and the probability of extinction. During the 50-year model period, all alternatives had low probability (5.4–6.0 percent) of quasi-extinction (dropping below one-eighth of the starting population). Similarly under all alternatives, after an initial annual decline of approximately 5 percent (related to assuming the population was 40 percent over carrying capacity or "*K*"), populations continued a steady decline of approximately 1.5 percent per year for the remainder of the modeling period (ending populations ranged from 1,039 to 1,092 murrelets).

When the model focused on just the theoretical DNR population with no dispersal, differences among alternatives in population response and the risk of quasi-extinction were more pronounced. Alternative F resulted in the greatest number of female murrelets (175) and lowest quasi-extinction probability (11 percent), whereas Alternative B resulted in the lowest population size (95 female murrelets) and highest quasi-extinction probability (42 percent). However, all alternatives showed a pattern of steeper initial population decline followed by continued steady decline of approximately 1.5 percent at levels appropriate to the *K* provided by each alternative.

ENHANCEMENT ANALYSIS

Similar to the risk analysis, little difference among alternatives was apparent at the statewide scale. For the Washington population, probability of quasi-extinction (dropping to one-eighth of the initial population) was zero or nearly zero for all alternatives. While murrelet numbers initially declined in the first few decades because the population was assumed to be over *K*, the population stabilized for the remainder of the planning period for all alternatives. Alternative F was projected to support the largest ending population (2,663 female murrelets) and Alternative B the smallest (2,368 female murrelets).

The hypothetical population limited to DNR-managed lands had very low probabilities of quasi-extinction under all alternatives (0.01–0.1 percent). All alternatives began with declining populations (during the first 2 decades) followed by gradual increases in response to increasing habitat for the remainder of the modeling period. Alternative F resulted in an ending population of 590 female murrelets, while B resulted in 328 female murrelets. Table 4.6.5 shows the mean ending female population sizes by alternative.

Table 4.6.5. Enhancement Analysis for Simulated DNR Sub-Population, by Alternative

	Projected mean population sizes after 10,000 simulations (number of female marbled murrelets)					
Year	**Alternative A (no action)**	**Alternative B**	**Alternative C**	**Alternative D**	**Alternative E**	**Alternative F**
0	542	542	542	542	542	542
10	393	355	420	397	423	467
20	343	276	392	354	401	466
30	350	277	408	368	419	496
40	375	302	445	402	455	541
50	406	328	482	436	491	590

COMPARING MODELED POPULATION RESPONSES AMONG THE ALTERNATIVES

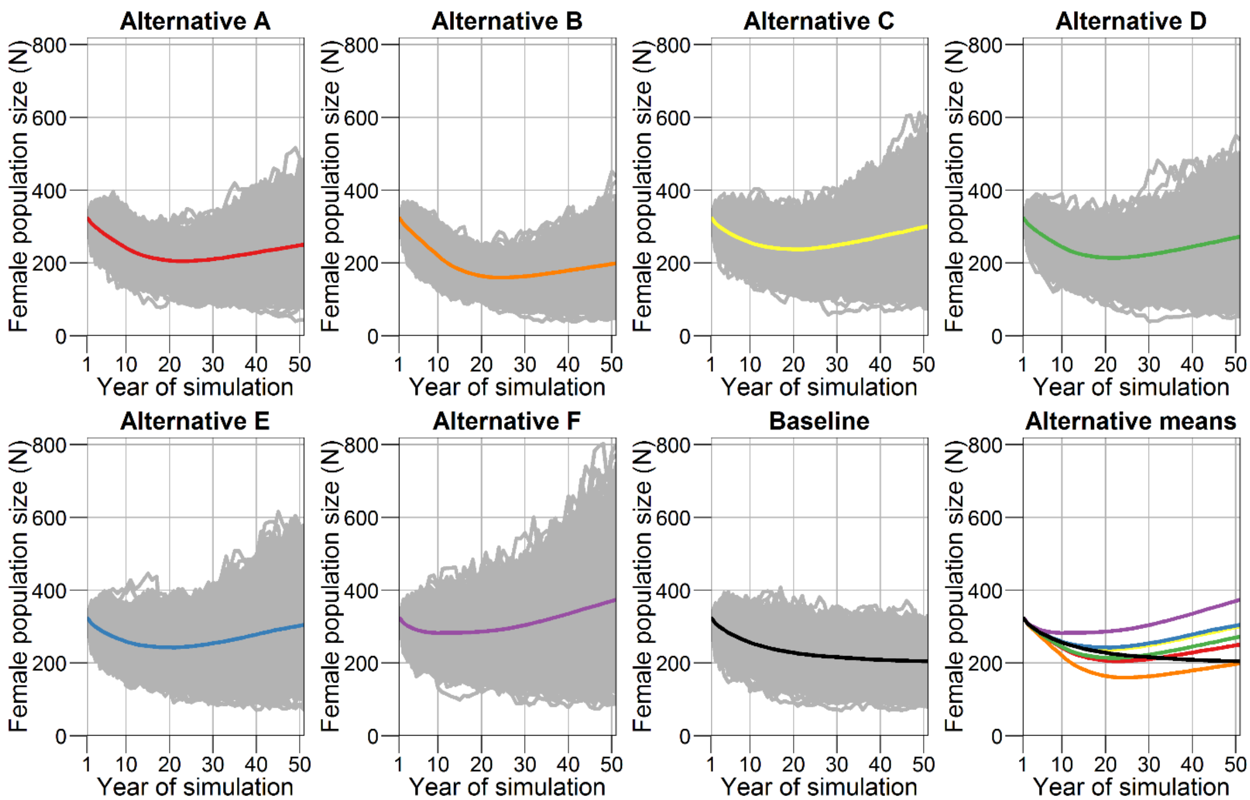
Model results for the Washington population of marbled murrelets showed no substantial difference in population size or quasi-extinction risk among the action alternatives (Appendix C).

For the DNR sub-population, Alternative B resulted in the lowest ending populations and the highest risk of quasi-extinction. Alternative F resulted in the highest population by the end of the planning period and lowest risk of quasi-extinction. Under the risk scenario, the simulated populations continued to decline even though *K*, which was directly related to adjusted habitat acreage, increased under all alternatives. However the enhancement scenario suggested a different pattern with gradual population increases reversing the initial declines in response to increased habitat on DNR lands. Refer to Figure 4.6.6.

In a separate sensitivity analysis, the modelers found the most influential factor in murrelet population growth was the amount of high-quality nesting habitat (P-stage values of 0.89 and higher). The populations were found to be less sensitive to edge conditions and the overall amount of nesting habitat which mostly reflected the abundance of low-quality habitat (P-stage values of 0.25 and 0.36).

Figure 4.6.6. Simulated Population Responses, by Alternative for the DNR Sub-Population Under the Enhancement Analysis (Copied from Peery and Jones 2016, refer to Appendix C)

The colored lines on each graph reflect the average of all 10,000 simulations, which are plotted in gray. Baseline as used in this figure is not the same as the no action alternative. Baseline represents a static habitat scenario where the raw amount of murrelet nesting habitat that presently exists on DNR lands remains constant over the 50-year modeling period. The baseline scenario offers a useful benchmark by which to compare scenarios with changing habitat conditions.



Conclusions: Changes in habitat and population response

All alternatives increase the acreage and quality of marbled murrelet habitat over the analysis period.

These projected increases are likely positive impacts on the DNR sub-population of birds, even when considered against the ongoing 4.4 percent population decline. If nesting habitat is the primary limitation on murrelet population growth, all alternatives result in a reversal of the population decline, with Alternative F resulting in the earliest reversal and greatest population increase. However, under the "risk" scenario, the population continues to decline because this scenario assumes a greater influence from chronic environmental stressors outside the forest. Key comparisons of the alternatives are summarized in Table 4.6.6.

Table 4.6.6 Comparison of Alternatives Based on Key Measures

Measure	Alternatives					
	A (no action)	B	C	D	E	F
Acres of habitat loss in first decade (not adjusted for quality)	36,000	49,000	35,000	42,000	34,000	25,000
Total unadjusted habitat acres (Decade 5)	333,700	316,600	338,000	329,800	339,900	371,700
Total adjusted habitat acres (Decade 5)	161,400	158,700	169,500	164,400	170,300	181,500
Adjusted acres of interior habitat by Decade 5 (percent change)	82,800 (21%)	67,300 (-1%)	93,700 (37%)	91,900 (35%)	95,800 (40%)	114,200 (67%)
Average P-stage, Decade 5	0.61	0.65	0.63	0.63	0.63	0.59
Decade to habitat recovery[5]	2	3	2	2	2	0
Ending female population for DNR sub-population (risk/enhancement)	74/ 251	54 / 199	90 / 301	78 / 272	91 / 305	107 / 374
Probability of the DNR sub-population falling below one-eighth of the starting population[6] (risk/enhancement)	22% / 0%	41% / 0%	11% / 0%	20% / 0%	10% / 0%	6% / 0%

Alternative B reflects the most harvest of marbled murrelet habitat in the first decade. It takes 3 decades for overall acres of habitat in LTFC to exceed this loss. Alternative B has the highest ending P-stage value, but this is due to including more occupied site acres (P-stage 1) relative to other P-stage categories. The population model shows that Alternative B has, by far, the smallest simulated population by the end of the analysis period, as well as the greatest quasi-extinction risk among the alternatives to marbled murrelet populations.

Alternatives C, D, and E are similar in the overall amount of acres conserved and the quality of those acres. Although Alternative D proposes the most initial harvest of habitat outside LTFC among these three alternatives, the overall value of the habitat retained and percentage of new interior habitat grown is higher than in the no action alternative.

[5] Decade to habitat recovery refers to the time it takes for habitat growth in LTFC to compensate for the habitat loss in the first decade as measured in adjusted acres.
[6] A 5 percent decline per year equates to a decline to one-eighth of the starting population in 40 years.

Alternatives C and E conserve isolated stands with P-stage 0.47 and higher, thus raising their overall habitat quality as compared to Alternative D. Alternatives C and E differ only slightly in the population responses. Alternative D lies in the middle of the range of the simulated population. An important distinction for Alternative D is that the loss of higher-quality habitat results in results in approximately 10 percent fewer murrelets in the modeled marbled murrelet population than in Alternatives C or E.

The greater area of LTFC and lesser harvest proposed in Alternative F results in a projected net habitat increase after the first decade, the most gain over time in interior habitat, the highest modeled population gains, and the lowest risk of quasi-extinction. Although this alternative conserves the most acres of potential habitat, the average habitat value in the final decade of the planning period is slightly lower than the other alternatives because more lower-quality habitat develops in the conservation areas. Alternative F conserves the most habitat, even when adjusting for edge effects.

Indirect effects on habitat: Disturbance

Marbled murrelets use DNR-managed forests for breeding and other essential behaviors from April 1 through September 23 in Washington. During this time, they can be exposed to audio-visual stressors from a variety of land use activities. Harvest and other forest management and use have indirect impacts on habitat quality by increasing the risk of disturbance to nesting marbled murrelets and chicks. Some of these stressors are related to habitat conditions, predator composition, and use in edges (described in preceding sections), and others are related to noise and visual disturbances from forest use and management activities. Sources of disturbance impacts are diverse and include road construction, maintenance, and use; timber harvest and recreational activities; aircraft; and rock pit operations and more.

A disturbance event is considered significant when an activity causes a murrelet to delay or avoid nest establishment, flush away from an active nest site, or abort a feeding attempt during incubation or brooding of nestlings. Indirect effects of campgrounds and day-use areas include locally increased populations of nest predators. Such events are considered significant because they have the potential to result in reduced nesting attempts, nest success, fitness, and/or survival of juveniles and adults, thus impacting the population (USFWS 2012).

The effect of many of these disturbances caused by new or expanded land use activities throughout the planning period are reduced by the conservation measures described in Chapter 2. There are also existing and ongoing disturbance effects that DNR evaluated to ensure that mitigation (the growth of new habitat) would be adequate to offset these negative influences over time.

Quantitative estimates of disturbance can be developed by determining the birds' likely response given the proximity, timing, duration, and intensity of stressors and converting that information into acres of quality-adjusted habitat exposed to stressors during the breeding season (Appendix I). However, uncertainties over the nature of murrelet responses to the range of potential disturbances, the location of murrelet nests, and the timing and location of potentially disturbing activities do not allow quantitative estimates of disturbance impacts similar to the estimates of habitat quality and quantity used to evaluate the impacts of harvest and development of murrelet habitat. Thus, while the spatial and temporal overlap of potentially disturbing activities with current and future murrelet habitat can be estimated, the impacts of potential disturbance to that acreage cannot be directly compared or tallied with habitat acreage.

Potentially disturbing activities were classified into six groups with similar characteristics, their average spatial and temporal distributions were estimated based on contemporary practices, and their spatial footprints were derived according to the appropriate distances. These disturbance footprints were intersected with the current marbled murrelet habitat map to estimate the areas potentially subject to those various disturbances. The estimates reported in Table 4.6.7 are based on the assumption that disturbance patterns will be approximately constant over the HCP term and that habitat conserved and developed under each alternative is exposed to disturbance approximately in proportion to its abundance. The estimates of annual habitat disturbance are based on the amount of habitat (Appendix I) estimated for the middle of the HCP term averaged across all alternatives. Cumulative disturbance can be estimated by multiplying acres disturbed annually by 51.

Table 4.6.7. Average Estimated Acreage of Murrelet Habitat Disturbed Annually During the Nesting Season, by Activity Group

Activity group	Stressor	Distance	Duration	Response/impact	Average habitat disturbed annually during nesting season (adjusted acres)
Group 1 (includes green collecting, pre-commercial thinning, non-motorized trail use, minor road maintenance)	Ground-based noise and visual disturbance	≤100 meters	< 1 day	No significant response based on duration; minimal to no impacts	9,200
Group 2 (includes firewood collection, road reconstruction, major road and trail maintenance, communications facilities)	Ground-based noise and visual disturbance	≤100 meters	< 7 days	Aborted feedings, adults flushing; disruption of normal behaviors	310
Group 3 (campground use and maintenance)	Ground-based noise and visual disturbance Predator attraction	≤100 meters	< 1 month	Increased predation risk, aborted feedings, adults flushing; potential injury and/or mortality	142

Activity group	Stressor	Distance	Duration	Response/impact	Average habitat disturbed annually during nesting season (adjusted acres)
Group 4 (includes timber harvest, motorized trail use, new road and bridge construction)	Ground-based noise and visual disturbance	≤100 meters	>7 days, < 1 month	Aborted feedings, adults flushing; disruption of normal behaviors	1,630
Group 5 (sand and gravel extraction, blasting)	Ground-based noise and visual disturbance	≤ 400 meters (0.25 mile)	>7 days, < 1 month	Hearing damage from blast noise (within 100 m), aborted feedings, adults flushing; injury; disruption of normal behaviors	52
Group 6 (aerial herbicide application)	Aircraft Noise	≤100 meters	< 7 days	Aborted feedings, adults flushing; disruption of normal behaviors	50

The most common and widespread types of disturbance, Group 1 activities (short duration, low intensity) are estimated to occur over 9,200 adjusted habitat acres annually but are not expected to have adverse effects. Group 2 and Group 4 activities are transient, widely distributed ground-based disturbances with similar expected murrelet response, which is disruption of normal behaviors that is estimated to occur over 1,900 acres annually. Groups 3 and 5 are ground-based disturbances from discrete facilities; together, they are expected to result in disruption of normal behaviors from noise and visual disturbance over 200 acres annually. In addition, Group 3 activities are expected to result in potential injury and/or mortality to murrelets in the form of increased nest predation in 143 acres annually, and blasting (Group 5) within 100 meters of nesting murrelets could also result in injury and/or mortality to about 5 acres annually. Group 6, aircraft noise, is expected to result in disruption of normal behaviors over 50 acres annually. Some of the disturbance estimated in one category will overlap in space and time with disturbance estimated in another category, so estimates of acres impacted may reflect cumulative impacts.

Estimates of acres of habitat gained and lost under the alternatives do not take into account the disturbance acres because those impacts do not result in habitat removal. Instead, the frequency, intensity, and amount of acres impacted from these disturbances informed conservation measures proposed under the action alternatives. These measures are designed to reduce the risk of these impacts and are more fully described in Chapter 2, Section 2.2. Table 4.6.8 summarizes how the conservation measures are expected to affect to marbled murrelets.

Table 4.6.8. Summary of Resulting Effects of Key Proposed Conservation Measures on Disturbance

Conservation measure	Potential disturbance impacts addressed	Resulting effect
Limiting harvest and thinning activities	Aborted feedings, adults flushing; potential disruption of nesting behaviors	Seasonal restrictions avoid activities during the nesting season, including reducing audio-visual disturbance from heavy equipment use, road construction, and related noise.
Seasonally restricting forest health treatment activities	Aborted feedings, adults flushing; potential disruption of nesting behaviors	Reduced risk to marbled murrelet specific conservation areas from audio-visual disturbances during peak activity periods for nest visits. Occupied sites are further protected from smoke from prescribed burns.
Limiting road construction	Aborted feedings, adults flushing; potential disruption of nesting behaviors	Alternatives B, E, and F: Creation of edge and audio-visual disturbance may occur as a result of some road construction through occupied sites, although consultation will likely minimize this risk. Habitat located outside occupied sites is subject to ongoing disturbance impacts from road construction. Alternatives C and D: Occupied sites, buffers, and special habitat areas will not receive new impacts from roads. Risk of road impacts may increase if more road miles must be built to avoid conservation areas.
Daily timing restrictions on road maintenance, decommissioning, or abandonment	Aborted feedings, adults flushing; potential disruption of nesting behaviors	Reduced risk to nesting birds in occupied sites from audio-visual disturbances during critical feeding hours. Other marbled murrelet conservation areas and low-quality habitat throughout the analysis area may experience audio-visual disturbance from these activities.
Limiting installation and placement of harvest-related infrastructure (tailholds, guyline corridors, etc.)	Habitat removal, aborted feedings, adults flushing; potential disruption of nesting behaviors	Reduced risk to platform trees from equipment. Reduces audio-visual disturbance to all marbled murrelet conservation areas. Reduces risk of habitat removal in occupied sites.
Limiting salvage and recovery activities during the nesting season	Aborted feedings, adults flushing; potential disruption of nesting behaviors	Reduced risk to nesting habitat in marbled murrelet conservation areas from audio-visual disturbance during critical feeding hours. Increases the potential recovery of high-quality habitat if it is damaged. Activities in low-quality habitat outside conservation areas are not restricted, which could result in some site-specific audio-visual impacts from recovery and salvage operations but may also allow more enhancement of low-quality habitat.
Restricting both location and timing of blasting	Hearing damage from blast noise (within 100 m), aborted feedings, adults flushing; potential injury or disruption of nesting behaviors	Reduced or eliminated impulsive noise impacts to nesting and potentially nesting murrelets within conservation areas. Murrelets nesting outside of these areas may be subject to disturbance from blasting. Alternatives C and D propose the strictest blasting limitations.

Conservation measure	Potential disturbance impacts addressed	Resulting effect
Limiting rock crushing and pile driving during nesting season	Hearing damage from impulsive noise, aborted feedings, adults flushing; potential harm or disruption of nesting behaviors	Reduced or eliminated impulsive noise impacts to nesting and potentially nesting murrelets during peak nest activity periods.
Limiting aerial activities during nesting season	Aborted feedings, adults flushing; potential disruption of nesting behaviors	Audio-visual disturbances from low-flying aircraft on nesting murrelets will be reduced in marbled murrelet conservation areas. Birds nesting outside these areas will be subject to these impacts.
Limiting the location of new or expanded recreation facilities and trails	Increased predation risk, aborted feedings, adults flushing; potential harm	Alternatives C and D: Risk of habitat removal, direct harm from predators, and increased audio-visual disturbances will be significantly reduced in marbled murrelet conservation areas, except isolated patches of high-quality habitat. Outside of conservation areas, disturbance from maintenance activities will be eliminated during critical nest visiting and feeding hours. Alternatives B, E, and F: Risk of disturbance will be reduced during critical nest visiting and feeding times. This restriction does not address the creation or use of undesignated trails or areas of recreational activities.
Restricting and mitigating the use of easements, rights-of-way, leases, and contracts where DNR has authority to do so	Aborted feedings, adults flushing; potential disruption of nesting behaviors	Reduced risk of audio-visual disturbances for maintenance activities and construction of new facilities during peak nest activity periods in conservation areas.

Potential changes to long-term forest cover through time

In addition to the direct impacts to marbled murrelet habitat from harvest and related activities and the indirect effects from ongoing land use activities within and adjacent to marbled murrelet habitat, long-term forest cover may be affected through time by disturbances and activities outside of the Joint Agencies' control. These impacts could come from landslide events, wind and fire events, or undesignated or illegal land use activities. These impacts could also come from new rights-of-way or easements required to provide utilities or road infrastructure or for legally required access to inholdings.

These impacts are anticipated to be generally minor at the scale of all LTFC and insignificant within marbled murrelet-specific conservation areas. For example, only between 4 and 6percent of the land proposed as marbled murrelet conservation areas and not already deferred for other conservation reasons is identified as having high landslide hazard potential using DNR data (refer to Section 3.1 for a description of these data). This does not mean that 4 to 6 percent of these areas will fail during the planning period. Activities that can trigger landslides will be restricted in these areas (for example, road building and harvest). However, there remains a small risk of habitat loss due to natural landslide events. Similarly, rare weather events such as catastrophic windstorms, while not exacerbated by the proposed alternatives (refer to Section 4.2, Climate) could result in some loss of long-term forest cover. Although potentially locally significant, these losses are not expected to be significant at the statewide scale during the planning period.

Those alternatives with a higher amount of mitigation than expected take (refer to Figure 4.6.5) would provide additional capacity to "absorb" or account for these impacts. Alternative F is the most resilient because it conserves the greatest amount of acreage across a wide geography, while Alternative B is least resilient because it conserves the least acreage and is the most geographically restricted.

Summary of impacts

The marbled murrelet population is declining in Washington. Habitat growth on DNR-managed land appears to have the potential to decrease the rate of this decline under some alternatives. The alternatives offer different approaches to habitat protection and habitat growth that, when analyzed and compared, illustrate some key differences in habitat amount and quality and estimated population response.

Table 4.6.9. Summary of Potential Impacts to Marbled Murrelets

Key question	Criteria	Measures	Potential impacts
How do the alternatives affect marbled murrelet nesting habitat, and how are changes to nesting habitat quantity and quality expected to affect the marbled murrelet population?	Compliance with ESA and HCP Need, purpose, and objectives	Amount and quality of habitat gained and lost	All alternatives result in more habitat gained than lost over time, with improved habitat quality and softened edge effects. In the short term, loss of mostly low-quality habitat outside of long-term forest cover will occur under any alternative, including the no action alternative. Within the first 2 decades, growth of new habitat and development of higher-quality habitat outpaces this initial habitat loss. When adjusted for quality, Alternative B is the only alternative with impacted acres exceeding acres of mitigation. Alternative D has the closest balance of impact to mitigation when factoring in habitat quality. Alternative F has significantly more mitigation acres than impact acres. Alternative F conserves the most additional habitat overall and has the most increase in interior habitat over time. Alternatives C through E also have substantial increases in interior habitat, while Alternative B has a slight reduction.
		Level of disturbance from forest management and land use activities	Disturbance impacts will be ongoing in LTFC but will be minimized inside occupied sites, buffers, and special habitat areas. Risk of disturbance within marbled murrelet conservation areas is minimized to the highest degree under Alternatives C and D. However, given the relatively small number of acres involved for most disturbance categories, this is a minor benefit.
		Relative comparisons of population projections over time, including risks of quasi-extinction	Alternative B has the highest risk of quasi-extinction. If nesting habitat is the primary limitation on murrelet population growth, all alternatives result in a reduced rate of population decline, and Alternative F shows the earliest reversal and greatest overall increase in population.

Key question	Criteria	Measures	Potential impacts
Do the alternatives provide habitat in important geographic locations for marbled murrelet conservation? These include southwest Washington and areas close to marine waters, including along the Strait of Juan de Fuca and in the North Puget planning unit.	Compliance with ESA and 1997 HCP Need, purpose, and objectives	Relative comparison of habitat conserved in important landscapes identified by Recovery Plan and or *Recovery Implementation Team Report* Relative comparisons of future habitat development in strategic locations	Southwest Washington: The no action alternative would protect approximately 81% of all known P-stage habitat in South Coast and 59% in Columbia. Alternatives C through E would protect more of this habitat, approximately 85% in South Coast and 75% in Columbia. Alternative F protects the most P-stage habitat in southwest Washington, protecting approximately 85% in South Coast and 91% in Columbia. Alternative B protects less: 65% in South Coast and 34% in Columbia (significantly less than the no action alternative). Close to marine waters: Alternatives C, D, and E provide more murrelet conservation near the Strait of Juan de Fuca compared with the other alternatives. Alternatives C and E provide additional habitat in OESF (including the Clallam Block) and Straits. Alternatives C through F emphasize murrelet conservation in important areas west of National Forestlands in North Puget (closer proximity to marine waters), and Alternative F provides additional habitat in North Puget. Alternative F provides the most overall future habitat development in important areas.

Minimization and mitigation for adverse impacts

All alternatives use areas of long-term forest cover as the primary conservation strategy to provide both minimization and mitigation for the impacts summarized in Table 4.6.9. These impacts include loss of habitat, ongoing edge effects, and ongoing disturbance. These impacts are mitigated by:

1) Conservation and development of marbled murrelet habitat in LTFC
2) Conservation of habitat in strategic locations on DNR-managed forestlands
3) Conservation measures designed to minimize the impacts of edges and disturbance (refer to Chapter 2 and Table 4.6.11).

4.7 Recreation

This section describes the potential effects of the alternatives on DNR recreation facilities and users in the analysis area.

Analysis question

- *How are recreational opportunities on DNR-managed lands affected by the action alternatives?*

Evaluation criteria

Impacts are evaluated against the quality and quantity of recreational opportunities available, as governed by DNR recreation planning policies and the multiple use concept.

Scale of analysis

The alternatives are analyzed at both the analysis area scale and at a "landscape block" level. The proposed conservation measures most directly affect recreation in landscape blocks where marbled murrelet conservation areas and designated recreation facilities and/or trails overlap.

How impacts are measured

Direct, indirect, and cumulative impacts are measured qualitatively, considering use-level trends through the life of the HCP and where designated recreation intersects with proposed marbled murrelet conservation areas.

Summary of direct, indirect, and cumulative impacts

Under the interim marbled murrelet strategy, Alternative A, existing HCP provisions and DNR policies for recreation planning will continue to be followed. Alternatives B through F include specific conservation measures that would impact new or expanded recreation in marbled murrelet conservation areas (refer to Chapter 2).

All of the action alternatives have the potential to clarify the geographical information that will be used in recreation planning. This is a positive impact in terms of adding certainty to where and what recreational opportunities will be allowed on DNR-managed lands with marbled murrelet habitat.

There are no significant adverse impacts identified at the scale of the analysis area. However, DNR may need to shift the focus of recreation within some landscape blocks where there are marbled murrelet conservation areas in order to accommodate a growing demand for recreation on state trust lands.

Direct impacts to recreational opportunities

There would be no anticipated direct impacts to recreation in the popular DNR-managed landscapes of Capitol Forest, Tiger Mountain State Forest, Raging River State Forest, Green Mountain State Forest, Tahuya State Forest, and Elbe Hills State Forest. These recreational landscapes do not have marbled murrelet conservation areas designated under Alternatives B through F; therefore, the conservation measures will not directly affect these areas when managing and developing recreation. These landscapes could be indirectly affected by the conservation measures if restrictions on recreation within marbled murrelet conservation areas shift more recreation to these landscapes (refer to the subsequent subsection, Indirect impacts).

For landscape blocks with existing designated recreation areas that are located within proposed marbled murrelet conservation areas, expansions of these facilities or development of new facilities will be limited. As demand for recreation continues to increase, so will public use of these existing areas and potential interest in expanding these areas.

Twelve (12) landscape blocks within the analysis area have existing recreational facilities that are located within proposed marbled murrelet-specific conservation areas. Some conservation measures proposed under the alternatives would limit new or expanded recreation within these areas while current uses would remain, as highlighted in Table 4.7.1.

Table 4.7.1. Existing Recreation in Landscape Blocks With Marbled Murrelet Conservation Areas

HCP planning unit	Landscape block	Type of facility impacted	Known areas with potential limitations on expansion
North Puget	Walker Valley	Motorized trails	Alternative F: A MMMA encompasses the northeast portion of the trail system.
Columbia	Elochoman	Motorized trails	Alternative F: MMMA encompasses a trailhead and ORV trail.
South Coast	Radar/Bear	Campgrounds	Alternative D: Two campgrounds are within special habitat areas. Alternative F: Two campgrounds are within a MMMA.
Straits	Port Angeles	Motorized trails	All alternatives have occupied sites and/or buffers that overlap a section of motorized trail.
Straits	North Crescent	Motorized trails	All alternatives have occupied sites and/or buffers that overlap a section of motorized trail.
Straits	North Crescent	Campground	All alternatives have occupied sites and/or buffers that encompass a campground.
OESF	Coppermine	Campground	Alternatives B through F have occupied sites and/or buffers that encompass a campground.

IMPACTS ON NEW OR EXPANDED RECREATIONAL OPPORTUNITIES: ALTERNATIVES C AND D

Alternatives C and D would restrict recreational development within occupied sites, buffers (including the 0.5-mile enhanced buffer in emphasis areas), and special habitat areas. This means that the areas limited for recreation will be more clearly defined with specific geographic areas, which could bring more certainty to planning new and expanded recreational opportunities.

However, potential impacts to strictly limiting new and expanded recreation opportunities in these areas include:

- Increased use of existing facilities and trails, requiring increased enforcement and maintenance.
- Increased volume of use within the landscape block, with the possibility of people going off trails or building trails without permission from the department, requiring increased enforcement and environmental mitigation.
- Development of other areas more suitable for recreational development, where available.
- Decreased recreation in this landscape block.

These potential impacts are not exhaustive. If there is sufficient public interest to expand recreational opportunities near existing designated recreation, DNR will need resources to identify suitable areas for recreational development that are consistent with the intentions and actions of the marbled murrelet conservation strategy and also meet the other land management and environmental obligations of the department.

Another potential impact of Alternatives C and D involves the requirement to consult USFWS to abandon or decommission non-designated trails in marbled murrelet conservation areas. Under the interim strategy, there is no specific requirement for consultation if the department needed to abandon, decommission, and potentially restore non-designated trails anywhere in the state to alleviate safety, environmental, or natural resource concerns. The additional step of consulting with USFWS when needing to abandon a trail in a marbled murrelet conservation area does add some uncertainty to outcomes. However, DNR and USFWS have a long history of working together to efficiently resolve implementation issues, and there is no reason to believe that would change.

IMPACTS ON NEW OR EXPANDED RECREATIONAL OPPORTUNITIES: ALTERNATIVES B, E, AND F

The conservation measure proposed for Alternatives B, E, and F provides DNR the flexibility to assess and potentially develop recreation opportunities within marbled murrelet conservation areas if there are no identified impacts to the marbled murrelet or if impacts can be mitigated through consultation with USFWS. The difference between these provisions and the no action alternative is that there would be a potential for recreational development in occupied sites and buffers, the 0.5-mile buffer in emphasis areas, and special habitat areas. If DNR wanted to pursue recreational activities in one of these places, they would conduct an impacts analysis. If impacts were identified, they would consult with USFWS. Where no impacts to the marbled murrelet are identified, DNR would not have to consult with the USFWS, and new or expanded recreation could move forward in these areas.

Where impacts are identified, DNR may choose not to pursue new or expanded recreation development, or may consult with USFWS. Because this is done on a site-specific basis, is not possible to describe what potential outcomes could entail. However, DNR and USFWS have a long history of working together to efficiently resolve implementation issues, and there is no reason to believe that would change.

IMPACTS TO MAINTENANCE ACTIVITIES (ALL ACTION ALTERNATIVES)

Daily timing restrictions for maintenance activities will likely have a low to minimal impact to recreation opportunities. The nesting season coincides with the most popular season for recreation on many landscapes as well as the optimal timing for many maintenance activities. Staff would have to take care to schedule maintenance work in marbled murrelet conservation areas outside of the daily timing restrictions, but it could likely be accomplished with reasonable accommodation. There are some maintenance activities that could reasonably occur outside of the nesting season.

Indirect impacts

An indirect effect of limiting new or expanded recreation development in some areas is that it may increase recreational pressure in other landscape blocks. It could create public pressure to develop recreational opportunities in landscapes that have not historically had designated recreation or in areas that are less environmentally suitable for recreation. There is also the potential for increased recreational use on landscapes with developed recreation, leading to increased need for management, maintenance, enforcement, and potentially expansion of designated opportunities.

Limiting recreational trail and facility development in one portion of a landscape might result in increased recreational use of open forest roads, public pressure to expand into other areas, and the development of trails without department permission. This could lead to higher resource needs for management, maintenance, decommissioning, restoration, and enforcement.

DISPERSED RECREATION

It is possible that restricting designated recreational development and expansion in landscapes with marbled murrelet conservation areas could indirectly impact dispersed recreation. Access for dispersed recreation happens from both designated facilities as well as from county roads, forest roads, and adjacent lands. Impacts could range from decreased access to displacing dispersed recreation to other forested blocks that may or may not be suitable for dispersed recreation activities. Unsuitable or concentrated dispersed use of an area can lead to impacts that require management, mitigation actions, enforcement, and the potential need to actively manage an area. Any expansion in recreation management requires additional staff and financial resources.

Cumulative impacts

The state's population is projected to grow by several million over the next 3 to 4 decades. The Washington State Recreation and Conservation Office completed an assessment of supply of outdoor recreation facilities and opportunities in Washington (RCO 2013). Their findings suggest that the current supply of recreation is not completely meeting public demand, and meeting that demand is further challenged by the pressures of population growth and urbanization in Washington. This is likely to intensify over the next several decades as public land available for recreation becomes more restricted. This increased pressure may result in additional use of existing facilities and trails, public interest to develop new facilities and new trails (both motorized and non-motorized), and an increase in trails being created without the DNR's permission in both landscapes with and without marbled murrelet conservation areas. Landscapes with marbled murrelet conservation areas may see public pressure for recreation where there is not currently much demand for recreation. This may result in management and enforcement issues to limit recreational use of an area and stay consistent with the HCP conservation strategies.

Increases in recreational volumes or expanded recreational development can create conflicts with adjacent landowners, trust income-generating activities, or environmental responsibilities. There are a variety of stakeholders that have interests in how DNR manages the lands, including, but not limited to, the trust beneficiaries, the environmental community, the Tribes, adjacent landowners, and the recreating public. In the future, if recreation on DNR-managed trust lands starts to significantly impact the basic activities necessary to fulfill trust obligations, recreational use will need to be evaluated for how to manage, eliminate, or compensate the trusts.

Table 4.7.2. Summary of Potential Impacts to Recreation

Key questions	Criteria	Measure	Potential impacts
How are recreational opportunities on DNR-managed lands affected by the alternatives?	Recreational opportunities are provided consistent with the Multiple Use Concept and other department policies Impending recreation plans	Use levels through life of HCP (trends) Designated recreation that intersects with marbled murrelet conservation areas	No impact to existing and dispersed uses. Clearly defined marbled murrelet conservation areas could provide more certainty to recreation planning. Restrictions on development in marbled murrelet conservation areas could shift recreation use to other areas or result in undesignated uses. Recreation planning can take into account potential restrictions on development, but this may affect some local user groups.

4.8 Forest Roads

This section describes the potential effects of the alternatives on DNR's network of forest roads in the analysis area, with a focus on whether changes to road use or management would affect other elements of the environment.

Analysis question

- *Do the action alternatives affect the location, amount, or use of forest roads to the extent that impacts to elements of the environment are significantly increased?*

Evaluation criteria

The location of proposed marbled murrelet conservation areas and the proposed conservation measures for these areas are compared against existing rules and policies governing forest roads to evaluate potential impacts.

Scale of analysis

The alternatives are analyzed at the analysis area scale. The action alternatives, including proposed conservation measures, provide uniformity for road work and management among the HCP planning units.

How impacts are measured

Impacts are evaluated qualitatively by estimating how the alternatives affect DNR road management and road work operations and determining if these effects significantly increase impacts to natural resources. Decisions for locating and managing roads happen on a site-specific basis, for example when evaluating an area for a timber sale, and these areas have yet to be determined. Therefore, the identification of specific impacts tied directly to the alternatives are based on stated assumptions about how the alternatives may affect roads, their location, management, and how those changes may in turn affect the risk to natural resources.

Summary of direct, indirect, and cumulative impacts

Numerous forest management policies and regulations address the potential environmental impacts from roads (refer to Section 3.8). The conservation measures would impose restrictions on the timing and location of some road-associated activities; however, these restrictions are similar to those currently implemented under the no action alternative. Proposed restrictions on road construction and blasting could have some indirect, localized effects on natural resources. While overall road density is not expected to increase significantly as a result of the alternatives, in some cases, additional road miles may be needed to avoid marbled murrelet habitat and conservation areas. Across the analysis area, it is unlikely that these changes would increase the risk of environmental impacts because of the existing regulations, policies, and guidelines designed to minimize these risks.

Some alternatives could have moderate impacts on road management activities, access to harvestable stands, and recreation use and access. Differences in impacts among the alternatives are highlighted below.

Effects from restrictions on road location and road work

The alternatives designate habitat that must be either avoided completely when locating roads or be subject to a review process that could result in locating roads away from habitat or conservation areas. These measures could result in the need for additional road miles, which could increase the number of stream crossings, or result in the need to construct roads in areas that may pose higher environmental risk. Longer roads in potentially less desirable locations (from a road construction standpoint) may have less impact overall than building through marbled murrelet conservation areas.

Conversely, roads proposed to be built within special habitat areas, occupied sites and buffers, and 0.5-mile buffers on occupied sites within emphasis areas may have less impact than building elsewhere. If the objective is to conduct activities that have the least impact for specific natural resources, the consultation process outlined for Alternatives B, E, and F may allow more flexibility to choose among the best locations with the fewest impacts. All road construction decisions would be evaluated on a case-by-case basis, and existing regulations and designed standards would be applied.

NEW CONSTRUCTION AND RECONSTRUCTION: ALTERNATIVES C AND D

Alternatives C and D prohibit new road construction or reconstruction through special habitat areas, occupied sites, and their buffers, including the 0.5-mile buffer around occupied sites within emphasis areas, unless otherwise required by state or federal laws or emergency.

From a road management perspective, these measures provide certainty to the process of assessing road location options, particularly in the North and South Puget planning units. However, these limitations could result in constructing longer roads to avoid certain areas. This could elevate risks to water quality and/or involve additional stream crossings or elevate risks to other natural resources. The existing regulatory framework would continue to provide environmental protections on a site-by-site basis. Access to operable lands may also be affected, which can have an effect on timber production.

Road reconstruction under Alternatives C and D is more restrictive than the no action alternative. This means that the long-term use of an existing road may be limited if the physical conditions of that road would deteriorate to the point of needing reconstruction. The physical work for road reconstruction is not significantly different from maintenance activities (work is conducted within the existing footprint). The proposed conservation measure that limits reconstruction could mean that DNR would see the elimination of road-decommissioning[7] activities in these areas because there would be no way to reopen the road again. This means that roads within special habitat areas, occupied sites and buffers, and the 0.5-mile buffer within emphasis areas may need to be abandoned, not decommissioned.

The indirect impacts of limiting road reconstruction include potentially cutting off access to operable stands, requiring more new road construction, or requiring more maintenance of existing roads. As with road construction, the limitation on reconstruction has the potential to increase impacts to other natural resources. However, existing regulations remain in place to minimize these impacts.

NEW CONSTRUCTION AND RECONSTRUCTION: ALTERNATIVES B, E, AND F

Options for road construction and reconstruction under Alternatives B, E, and F provide more flexibility within marbled murrelet conservation areas than under Alternatives C and D for siting new roads, conducting road work on existing roads, and reconstructing decommissioned roads. There are uncertainties with how site-specific decisions will be made under a consultation process between the USFWS and DNR, but these agencies have a history of working together to implement the HCP efficiently, and there is no reason to believe that would change.

Alternatives B, E, and F affect road reconstruction to a slightly lesser extent than Alternative C and D because reconstruction is not prohibited outright within marbled murrelet conservation areas. Under Alternatives B, E, and F, road reconstruction conservation measures are similar to the no action alternative in the OESF (see Table 3.8.3) but are more restrictive in the other HCP planning units.

Alternatives B, E, and F potentially allow more road construction through habitat than Alternatives C and D, which would not only remove potential habitat but could also affect the quality of existing habitat by creating more edges. Forest edges created from harvesting and roads impact the security of marbled murrelet habitat by compromising the shape and amount of interior forest patches within LTFC and introducing predators.[8] Only about 5 percent of habitat is currently impacted by the road edge effect.[9] Due to the individual analysis needed for each road location, site-specific impacts to natural resources cannot be determined at this time. The existing regulatory framework would continue to provide environmental protections designed to minimize risks.

ROAD MAINTENANCE, DECOMMISSIONING, AND ABANDONMENT (ALL ACTION ALTERNATIVES)

There are no significant differences in terms of road maintenance, decommissioning, and abandonment between the no action alternative and the action alternatives. This type of road work is best conducted during the summer construction season, which aligns with the nesting season. Working in wet conditions increases the risk of sediment delivery, reduces the ability to compact road fill or surfacing adequately, and increases damage on existing roads from equipment due to weak soil conditions. Allowing work to

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[7] Road decommissioning reduces the need to maintain roads between long periods of timber harvest inactivity. This reduces the long-term maintenance costs of the road and decreases impacts from hauling and other traffic, sediment delivery, and flooding.

[8] Appendix G: Long-term Forest Cover Focus Paper

[9] Refer to Section 3.6 and Appendix H: Potential Impacts and Mitigation Focus Paper.

occur during the nesting season but within the daily timing restrictions, as proposed under all the action alternatives, is not expected to increase risk to natural resources.

STREAM CROSSINGS (ALL ACTION ALTERNATIVES)

All action alternatives would add approximately 16,000 acres of occupied sites to the conservation strategy compared to the no action alternative. This increases the number of culverts that would be located within occupied sites and buffers (increasing from 212 to 287 culverts); the number of bridges increases from 39 to 52. Maintenance and replacement work on these structures may be required. Stream crossing replacements are required by the need for fish passage, increased hydraulic capacity, emergency replacement due to failure, or scheduled replacement due to age and deterioration; all of these actions fall under the state or federal law or emergency exemptions provided in the conservation measures. New stream crossing locations would need to follow the guidance for new road construction or road reconstruction under the alternatives. Therefore, the conservation measures of the action alternatives would not increase risk to natural resources.

ROCK PIT DEVELOPMENT AND EXPANSION (ALL ACTION ALTERNATIVES)

Where new construction is prohibited under the interim strategy, rock pits would be also be prohibited. Alternatives C and D do not change this basic limitation, but they expand the areas where this prohibition would occur. Therefore, more valuable rock sources could go undeveloped, creating the need for hauling longer distances to other existing rock pits, developing new rock pits in non-restricted areas, or purchasing material from commercial sources. This could result in increased haul trips on forest roads, increasing wear and tear and exacerbating potential environmental impacts. More flexibility is provided under Alternatives B, E, and F, but restrictions on new pit development in the highest priority habitat is still anticipated.

Rock pits can include relatively large areas, and expanding existing rock pits in marbled murrelet conservations areas may have less adverse effects to some natural resources than constructing a new rock pit outside conservation areas. As with new road construction, the risk to natural resources would be reviewed on a case-by-case basis. The existing regulatory framework would continue to provide environmental protections.

Noise-generating activities

CHANGE IN TIMING OF NESTING SEASON (ALL ACTION ALTERNATIVES)

The action alternatives all expand the nesting season currently followed under the interim strategy (April 1 through August 31) to April 1 through September 23. This would restrict more of the summer construction season and the majority of the hydraulic work window. Shifting road work to outside the summer construction season could affect road stability, resource protection, and project scheduling; however, this may not be necessary because most road work can be accomplished outside the peak activity periods, following morning and evening daily timing restrictions as proposed by the conservation measures. If activities are allowed with daily timing restrictions, there is no increased risk to natural resources.

BLASTING RESTRICTIONS

Compared to the no action alternative, the number of rock pits within occupied sites goes up from six to eight, and the number of rock pits within 0.25 mile of an occupied site increases from 27 to 38. (Again, this is due to the action alternatives using an expanded set of occupied sites, as described in Chapter 2 and Appendix E.) Conservation measures for the action alternatives apply to rock pits located in special habitat areas and within 0.5 mile of an occupied site in an emphasis area.

Table 4.8.1. Number of Rock Pits Affected by Blasting Conservation Measures

Area of blasting restriction	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
Occupied sites	6	8	8	8	8	8
Within 0.25 miles of occupied sites	27	38	38	38	38	38
Special habitat areas/MMMAs	0	0	8	22	22	55
0.5-mile buffer in emphasis areas	0	0	8	0	8	0
Total	33	46	62	68	76	101

Alternatives C and D

During the nesting season, blasting associated with rock pits or road building would be prohibited in or within .25 miles of occupied sites, buffers, and special habitat areas. Blasting is prohibited within .5 miles of an occupied site within an emphasis area. The number of rock pits out of production for manufacture, expansion, or development during the nesting season (when most road work occurs) would increase from 33 to 62 (Alternative C) or 68 (Alternative D) between the no action alternative and the action alternatives.

Blasting restrictions would hamper the production of aggregate from these identified rock pits. Work within rock pits is typically accomplished during the summer construction season when conditions are better than the wetter fall through spring months. Similar to the prohibitions for new rock pit development and expansion, restrictions on blasting activities would create the need for longer haul distances to other existing rock pits or purchase of material from commercial sources.

Impacts on natural resources due to rock blasting would be reviewed on a case-by-case basis and cannot be determined at this time. Creating new rock pits outside of conservation areas could pose more risk to some natural resources than blasting in existing rock pits due to impacts from hauling rock further and impulsive noise effects on other species.

Alternatives B, E, and F

During the nesting season, blasting could potentially occur in or near marbled murrelet conservation areas, based on consultation between DNR and USFWS to avoid, minimize, and mitigate impacts to nesting birds. Consultation for blasting within the existing footprint of a rock pit would only determine if blasting could be accomplished with daily timing restrictions. If blasting is allowed through consultation, there is no increased impact on natural resources. If not, the same impacts under Alternatives C and D would be expected.

CRUSHING RESTRICTIONS (ALL ACTION ALTERNATIVES)

The conservation measures propose to restrict rock crushing within 110 meters (≤120 yards) of occupied sites. Within these areas, rock crushing must take place outside the nesting season when feasible; if rock crushing must take place within the nesting season, daily timing restrictions are imposed. Rock crushing typically occurs during the summer construction season, so restricting rock-crushing activities during the nesting season will be challenging, but not impossible, depending on weather. The timing restrictions would not be difficult to follow. The proposed distance buffer for this noise-generating activity is smaller than that applied under the interim strategy (0.25 mile), but the area to which the buffer applies would increase. Because crushing operations are allowed with timing restrictions if working outside the nesting season is unfeasible, the action alternatives would not increase risk to natural resources.

PILE DRIVING (ALL ACTION ALTERNATIVES)

As with rock crushing, pile driving is restricted within 110 meters (≤120 yards) of occupied sites. This is also a decrease in distance from the interim strategy (0.25 mile). Within these areas, pile driving must take place outside the nesting season when feasible; if pile driving must take place within the nesting season, daily timing restrictions shall be followed. Pile driving is typically associated with bridge construction. Because the nesting season is during the hydraulic work window, conducting this activity outside the nesting season would be unlikely, but following daily timing restrictions would be easy to implement. Because pile-driving operations are allowed with timing restrictions if working outside the nesting season is unfeasible, the action alternatives would not increase risk to natural resources.

Indirect and cumulative potential impacts on road management

Increasing acres of marbled murrelet conservation may make timber harvesting and road planning more difficult and expensive. Smaller harvestable stands may not have the timber volume to support extraction and could cause more road construction to connect these small harvestable patches into a viable timber sale. This is common in eastside forests where more road is built to reach enough volume to produce income from a timber sale. Even though timber harvesting is still possible, any extra road length or road work affects how much revenue the timber sale is able to produce. The cumulative impacts of road work restrictions; mobilization of harvesting equipment; restrictions on guylines, tailholds, landings, and yarding corridors; and location of marbled murrelet conservation areas could put some additional forestland out of production.

INDIRECT EFFECTS ON ROAD ABANDONMENT

Historically and under the no action alternative, road abandonment has been driven by environmental concerns and protection of resources. The choice to abandon roads is also guided by management decisions concerning use, road density, and costs, but not to the extent of resource protection. Costs, however, are typically driven by environmental concerns. For example, a road will be abandoned if the cost to eliminate fish barrier culverts outweighs the costs and benefits of replacement and reconstruction of the road. Most of the road abandonment activities on DNR-managed lands have been accomplished during road maintenance and abandonment planning (RMAPs) as required by forest practices rules. Taking more land out of timber production results in reassessing the road network and abandoning the roads that are no longer needed to manage land.

POTENTIAL FOR AN INCREASE IN ROAD MILES

At the scale of the analysis area, overall road miles are not likely to change significantly under any alternative. Road density may remain stable or decrease within the high-priority habitat but could either remain stable or increase in non-marbled murrelet conservation areas where road construction is not as restricted. The use of abandonment is expected to continue in the future to keep the forest road system mileage in check.

For a particular landscape or watershed, an increase or decrease in road density as a result of added marbled murrelet conservation could be significant. Because new road locations are assessed on an individual basis, the actual impact to the environment is not evaluated at this time.

NON-TIMBER USE AND ACCESS

Roads are the main access points for public recreation. Road abandonment or restrictions on new road construction or recreational use within marbled murrelet conservation areas could limit access to established recreation sites or areas used for dispersed recreation. Access to non-timber forest products may also be more limited, which could have indirect impacts to local economies. (Refer to Chapter 4.11, Socioeconomics.) Increases in unauthorized road use or undesignated trail building could result if significant restrictions are put in place on roads in areas of high recreational use. Access to other types of facilities (for example, private inholdings, leased lands, or utility corridors) could also be affected by limitations on road construction or reconstruction.

Summary

Table 4.8.2 provides a summary of potential impacts to forest roads and associated natural resources that are potentially impacted by these roads. Specific adverse impacts are difficult to pinpoint because road management decisions are largely made on a site-specific basis. No changes are proposed to the rules, policies, and procedures that are in place to minimize and mitigate environmental impacts from road construction and management. The conservation measures do propose restrictions on the location of roads and associated rock pits and the timing of road work. This could result in indirect effects to other natural resources. Strictly limiting road construction in some areas could also cause access problems for operable forest stands and for recreation.

Table 4.8.2. Summary of Potential Impacts to Forest Roads

Key questions	Criteria	Measure	Potential impacts
Do the action alternatives affect the location, amount, or use of forest roads to the extent that impacts to elements of the environment are significantly increased?	Forest practices rules *Policy for Sustainable Forests* 1997 Habitat Conservation Plan	Required road work (construction, reconstruction, maintenance, decommissioning, and abandonment) Miles and density of roads Number of rock pits and stream crossings Timing of activities for environmental protection and optimal construction	Localized increases in road miles may occur, but road density in the analysis area is unlikely to increase as a result of the alternatives. Increased road abandonment in conservation areas would also likely occur. Alternatives C and D: Additional road miles may be needed to avoid construction in marbled murrelet conservation areas. Potential impacts to aquatic resources and wildlife would be minimized through existing regulations, policies, and design guidelines. Alternatives B, E, and F: New road development through marbled murrelet conservation areas could remove habitat, create new edge effects, and reduce the quality of the habitat. The consultation process outlined for Alternatives B, E, and F allows more flexibility than Alternatives C and D to choose among the best locations with the fewest impacts. Indirect impacts could also occur to recreation and other user access; there is a potential for increased unauthorized use. Restrictions on road reconstruction can cause decreased use of road decommissioning as a management tool and increased construction of duplicate access roads, increasing the road density adjacent to the marbled murrelet conservation areas. Rock pit development could be shifted to outside conservation areas, with some localized impacts to other noise-sensitive species and wildlife habitat.

Potential mitigation for adverse impacts

ROAD RECONSTRUCTION

The conservation measures for road reconstruction could be adjusted to apply only to increases in the size of the road prism. For reconstruction that does not increase the existing road prism, a conservation measure similar to road maintenance would be adequate (following daily timing restrictions in proximity to habitat). Reconstruction required to widen the road prism could be treated like new construction and be prohibited in marbled murrelet conservation areas under Alternatives C and D or restricted under Alternatives B, E, and F.

BLASTING

Adjusting the restrictions on blasting to allow rock production within the existing footprint of a rock pit, following daily timing restrictions, could reduce the need to develop new pits in other sensitive areas**.** Other rock pit activities such as stripping, ripping, and loading are not covered under the long-term conservation strategy. These activities all include the use of heavy equipment, and guidelines to address these activities could help minimize risks of disturbance to nesting birds.

4.9 Public Services and Utilities

This section describes the potential effects of the alternatives on DNR-managed lands used for providing public services such as energy production and communication.

Analysis questions

- *Would the alternatives affect siting, management, maintenance, or in-kind replacement of existing communication and energy-related uses?*
- *Would the alternatives reduce high-potential opportunities for DNR to sell additional rights-of-way and leases for new or expanded communications and energy-related uses?*

Evaluation criteria

The criteria for communications and energy-related uses is that safety and reliability of existing facilities are maintained, state trust revenues are retained, and that opportunities for development of high-potential future uses are not irretrievably lost.

The specific performance standards for meeting these criteria are as follows:

- Consistency between long-term murrelet conservation measures (as defined in the alternatives) and existing uses of or contractual agreements for communication and energy-related leases.
- Continuation of access to existing rights-of-way or communication sites.
- Sustained ability to maintain, repair, and replace existing transmission lines or communication facilities as needed to ensure reliability and safety.
- Ability to develop new or expanded transmissions lines, telecommunication sites, and high-potential energy resources are consistent with murrelet conservation measures.

Scale of analysis

General effects of the alternatives on utilities, communications, and energy-related facilities are considered for the analysis area as a whole. Where existing major facilities or potential future uses are located adjacent to specific marbled murrelet conservation areas, effects are noted at the HCP planning unit scale.

BPA transmission line corridor (upper left to center right) crossing state trust lands in the Green River area, northwest of Enumclaw (South Puget planning unit)

How impacts are measured

Potential adverse impacts on communication and energy-related infrastructure and uses are expressed with the following measures:

- Location and extent of marbled murrelet conservation areas adjacent to existing and high-potential future communications and energy-related uses, including transmission lines and oil and gas leases.
- Adequacy of the 1997 HCP to address effects on marbled murrelet habitat from high-potential new uses and from management, maintenance, replacement, or expansion of existing uses.

In addition, the analysis considers qualitatively the status and trends of leases and easements with the amount of marbled murrelet conservation and the conservation measures proposed for each alternative as a general indicator of potential constraints on DNR sales of leases and rights-of-way.

Summary of direct, indirect, and cumulative impacts

Effects of alternatives on utility rights-of-way

EXISTING RIGHTS-OF-WAY

Increasing marbled murrelet conservation areas on state trust lands could potentially restrict the timing of maintenance and repair activities within existing rights-of-way. Restrictions are most likely where marbled murrelet conservation areas would be established adjacent to existing rights-of-way.

In such areas, transmission line maintenance work—such as vegetation clearing and helicopter-based inspections or transport of materials—would need to follow aerial activity distance thresholds and daily timing restrictions during the nesting season.

DNR does not currently have all utility corridors mapped, so a complete analysis of where proposed marbled murrelet conservation areas are located near existing corridors could not be done. The agency does have updated data on BPA transmission line corridors, which cover approximately 118 miles of DNR-managed lands in the analysis area. Table 4.9.1 illustrates the portion of BPA rights-of-way that are currently located near proposed marbled murrelet conservation areas.

Table 4.9.1. Approximate Mileage of BPA Rights-of-Way Within 0.5 Mile of a Marbled Murrelet Conservation Area

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Miles	20.9	20.2	52.4	28.9	52.7	34.5
Portion of Total miles of BPA rights-of-way in analysis area	18%	17%	44%	24%	44%	29%

Most of these corridors do not travel directly through marbled murrelet conservation areas. The most notable overlap of corridors and proposed conservation is located in the following areas:

- The North Puget planning unit near Goldbar (U.S. Route 2)
- South Puget planning unit in the Green River Watershed (near Enumclaw)
- South Coast planning unit east of the Long Beach Peninsula

Only the area in the South Coast planning unit would have additional marbled murrelet conservation areas designated on both sides of an existing BPA corridor under two alternatives. Alternative D designates the lands adjacent to this corridor as special habitat area, and Alternative F designates these lands as MMMA.

Based on this sample, and considering the conservation measures proposed, additional marbled conservation is not likely to substantially interfere with the ability of utility companies or other easement-holders to maintain system operations, reliability, and safety within the analysis area.

REPLACEMENT PROJECTS AND NEW RIGHTS-OF-WAY

All transmission line structures (for example, steel towers or H-frame wood poles) at some point require replacement. Replacement projects generally involve replacing individual structures, sometimes involving additional clearing in the right-of-way to accommodate larger structures.

The Radar Ridge communication site in Pacific County (South Coast planning unit). Photo: DNR

New transmission projects may also be planned to meet new or increased energy demands. New projects often occur within and adjacent to existing rights-of-way. Therefore, potential future constraints on transmission line expansion are most likely to occur in areas where marbled murrelet conservation areas would be established adjacent to an existing transmission corridor.

In addition, replacement projects may require that existing road networks be expanded. Alternatives C and D would restrict new road construction within marbled murrelet conservation areas, which could cause conflicts for accessing facilities. Alternatives B, E, and F provide more potential flexibility to construct roads using a consultation process between the Joint Agencies.

Effects of alternatives on leases for communications and energy-related facilities

COMMUNICATION SITES

Effects of the action alternatives on existing communication sites within the analysis area are limited to distance thresholds for helicopter-based inspections, maintenance, or repairs. Between 18 and 21 existing sites are currently located within proposed marbled murrelet conservation areas. Proposed conservation measures could affect the timing of maintenance and repair activities at these sites. Review and consultation with DNR and USFWS may be necessary to avoid disturbance impacts from these activities if they must be conducted during the nesting season.

Chinook helicopter transports a replacement structure to a remote portion of transmission line. Photo: BPA

New leases for communication sites will be limited in occupied sites, special habitat areas, and 0.5-mile buffers within emphasis areas under the proposed conservation measures for all action alternatives. Consultation between DNR and USFWS will be necessary to avoid habitat impacts in these areas. Specific sites anticipated for new leases cannot be known at this time. Given the amount of land still available for new leases within the analysis area and the availability of existing sites to co-locate new services, this is not anticipated to be a major impact to public communication services.

GEOTHERMAL ENERGY PRODUCTION AND OIL AND GAS LEASES

No planned or other reasonably foreseeable geothermal energy sites or oil and gas leases are located within existing or potential new marbled murrelet conservation areas. While Alternatives C, D, E, and F would all increase restrictions on geothermal and oil and gas leases over existing levels, there are no proven or high-potential energy resources that would be irretrievably lost due to any of the alternatives.

Cumulative effects

Additional restrictions on DNR-managed lands due to additional marbled murrelet conservation areas that would occur under Alternatives C through F (particularly Alternative F) would add to the extensive set of environmental restrictions that already apply to rights-of-way and leases for communications and energy-related uses. However, due to the relatively small number of acres affected and the existing consultation process used by the Joint Agencies, none of the alternatives are expected to contribute significantly to the cumulative regulatory burden of rights-of-way and leases for communications and energy-related uses.

Table 4.9.2. Summary of Potential Impacts on Public Services and Utilities

Key questions	Criteria	Measure	Potential impacts
Would the alternatives constrain management, maintenance, or in-kind replacement of existing communication and energy-related uses?	Safety and reliability of existing facilities is maintained State trust revenues are retained Consistency with marbled murrelet conservation Access to existing infrastructure is maintained No substantive reduction in ability to maintain, repair, and replace existing transmission lines or communication facilities as needed to ensure reliability and safety	Location and extent of additional marbled murrelet conservation areas (LTFC) adjacent to existing and high-potential future communications and energy-related uses	The addition of LTFC and its conservation measures may complicate ongoing maintenance, repairs, replacement, and expansion of some communications and energy-related facilities. The review and consultation process provided by the conservation measures should be able to address these complications.
Would the alternatives reduce high-potential opportunities for DNR to sell additional rights-of-way and leases for new or expanded communications and energy-related uses?	Opportunities for development of high-potential future uses are not irretrievably lost	Consider status and trends of leases and easements, together with the amount of additional marbled murrelet restrictions for each alternative, as general indicators of potential constraints on DNR sales of leases and rights-of-way.	No recognized high-potential sites are located within proposed marbled murrelet conservation areas. However, habitat that develops under the alternatives may be unavailable for communications and energy-related uses where DNR has discretion or authority over siting.

4.10 Environmental Justice

This section describes the potential effects of the alternatives on low-income or minority populations.

Analysis questions

- *Would the action alternatives result in disproportionately high and adverse impacts on low-income or minority populations?*

Evaluation criteria

The criterion for environmental justice is whether the action alternatives would result in disproportionately high and adverse impacts on low-income or minority populations.

Specific measures for evaluating these criteria are as follows:

- Adverse human health effects—including effects on air quality, water quality, noise pollution, traffic, aesthetics, or quality of life—are not disproportionately high and adverse for low-income or minority populations.
- Adverse economic effects do not reduce the economic viability of low-income or minority communities or populations.

Scale of analysis

Environmental justice issues are considered at the scale of the analysis area for general trends and effects on Hispanic and American Indian communities. The analysis looked for counties that contain both (a) higher than average low-income or minority populations (relative to other counties within the analysis area) and (b) relatively high amounts of state trust forestlands that would be deferred from harvest under one or more of the alternatives.

Effects related employment are related to the analysis conducted in Section 4.11, Socioeconomics. Issues related to traditional tribal access and uses of state trust lands are addressed in Section 4.12, Cultural Resources.

How impacts are measured

The potential for adverse human health effects is measured qualitatively based on the degree to which resources related to human health would be affected, including air and water quality, noise, and the visual environment.

The magnitude of effects is measured by acres of marbled murrelet-specific conservation. The context of local and regional economies is measured with a qualitative review of the literature to determine (a) general occupational and employment conditions and trends for low-income and minority workers, and (b) the degree to which forest-related work contributes to those conditions and trends.

Impacts related to reduced trust payments and potential indirect effects on low-income and minority communities are based on the analysis presented in Section 4.11, Socioeconomics.

Summary of direct, indirect, and cumulative impacts

Adverse human health effects

The alternatives evaluate varying amounts of marbled murrelet conservation. None of the alternatives would generate toxic waste; air, water or noise pollution; traffic congestion or hazards; or visual blight or otherwise cause environmental harm or risks to human health to any individuals or communities, including low-income or minority communities.

Adverse economic effects

HARVEST OF FOREST GREENS AND OTHER NON-TIMBER RESOURCES

Low-income or minority collectors of forest greens are not likely to be disproportionately affected under any of the alternatives. None of the alternatives propose further restrictions on the harvest of forest greens and other non-timber resources. The potential reduction in access to forest green harvest sites due to limitations on road and trail building in marbled murrelet conservation areas under Alternatives C, D, E, and F is minor in relation to the amount of available collection sites located throughout private, state, and federal forestlands within the analysis area.

TIMBER-RELATED LABOR

Depending upon the alternative, there will be various amounts of land available for full range of management options (refer to Section 4.11). Some alternatives have more restrictions on timber harvest than others. As described in Section 4.11, Pacific and Wahkiakum counties have the highest potential for reduced timber harvest, and they have low economic diversity, resulting in potential loss of income to low-income and minority populations. For these two counties, all action alternatives, with the exception of Alternative B, would result in higher amount of dedicated acreage for marbled murrelet conservation. Pacific and Wahkiakum counties do not have minority or low-income populations higher than the average among counties in the analysis area. Although minority and low-income populations could be negatively affected, the effect will not vary or result in a disproportionate impact from that on the rest of the population.

In the context of the more than 2 million acres of private, state, and federal forestlands located in these counties, the expected change in timber harvest is relatively small. The volume of timber harvested on DNR-managed lands would be reduced, which means fewer workers would be needed on those lands.

However, thinning would still be allowed throughout LTFC, with the exception of special habitat areas (under Alternatives C, D, and E) and occupied sites. This work would likely provide economic opportunities for members of low-income and minority communities.

INDIRECT IMPACTS: GOVERNMENT SERVICES FOR LOW-INCOME AND MINORITY POPULATIONS

As discussed in Section 4.11, Socioeconomics, all counties that have a reduction in acres available for harvest could experience a reduction in local revenues. Counties whose workforce is closely tied to logging, including Pacific and Wahkiakum, would be most affected by Alternatives C through F. This in turn could affect government services that may be providing support to low-income and minority populations. However, most government services that support low-income and minority populations are provided by state and federal funding rather than local funding, including government services such as Basic Food benefits (food stamps), Supplemental Security Income (SSI), State Family Assistance (SFA), and the Employment Security Department programs.

Collectively, these factors indicate that none of the alternatives is likely to cause disproportionately high and adverse economic effects on low-income or minority communities.

Table 4.10.1. Potential Impacts Related to Environmental Justice

Key questions	Criteria	Measures	Potential impacts
Would the alternatives result in disproportionately high and adverse impacts on low-income or minority populations?	Adverse human health effects—including effects on air quality, water quality, noise pollution, traffic, aesthetics, or quality of life—are not disproportionately high and adverse for low-income or minority populations. Adverse economic effects do not reduce the economic viability of low-income or minority communities or populations.	A qualitative review of the literature to determine general occupational and employment conditions and trends for low-income and minority workers	None. The proposed action is focused on marbled murrelet conservation, and none of the alternatives would generate toxic waste; air, water or noise pollution; or traffic congestion or hazards or otherwise cause environmental harm or risks to human health to any individuals or communities, including low-income or minority communities. The alternatives are expected to reduce total demand for forest sector labor, and this change could be significant for Pacific and Wahkiakum counties. However, the magnitude of such effects is not likely to cause disproportionately high and adverse economic effects on low-income or minority populations.

4.11 Socioeconomics

This section analyzes the potential impacts from the alternatives to social and economic values in the analysis area. The analysis questions cover three broad areas: government revenue, employment, and community values.

Analysis questions

- *How do the action alternatives affect trust revenue over the life of the HCP?*
- *How do the action alternatives affect county and state government revenue from other sources over the life of the HCP?*
- *How do the action alternatives affect county employment levels over the life of the HCP?*
- *How do the action alternatives affect environmental services and non-timber economic activities over the life of the HCP?*

Evaluation criteria

The action alternatives include proposed conservation measures that affect the operation and management of DNR-managed forestlands with marbled murrelet habitat in the analysis area. The alternatives do not provide a harvest schedule, which is a plan for future harvests. Without a harvest schedule, it is not possible to evaluate changes based on changes in the location and yield of timber sales, such as revenue distribution. Potential harvest schedules are being developed as part of an update to the sustainable harvest calculation (currently being drafted). These schedules will evaluate a range of marbled murrelet conservation alternatives as described in this DEIS but will combine these constraints with other considerations in order to establish alternative harvest schedules.

Text Box 4.11.1

Can we evaluate exactly how the alternatives impact local revenue?

The marbled murrelet conservation strategy does not include a harvest schedule. Without a harvest schedule, it is not possible to evaluate impacts related to specific changes to location and yield of timber sales, which directly impact revenue distribution.

We can, however, evaluate potential revenue impacts in a more generalized way by considering acres available for harvest. Over long time periods such as a harvest rotation, revenue is related to the area available for harvest. The area available for harvest under each alternative is known. This analysis is therefore based on the change of acres available for harvest using a weighted “operable acre” unit (designed for purposes of this DEIS analysis only). Operable acres are weighted by their assumed operability potential. Uplands with general objectives are areas where HCP, *Policy for Sustainable Forests*, and all relevant laws apply. They are weighted equal to their area in acres. Uplands with special objectives are areas where, in addition to general objectives, objectives such as northern spotted owl or hydrologic maturity objectives apply. They are weighted at one-third of their area because harvest area or volume removal is limited. Riparian areas are weighted at 1/33 of their area based on the actual harvest level in these areas over the past ten years.

Scale of analysis

The scale of analysis in this section varies depending on the aspect of interest. Impacts are assessed for counties, trusts, and the Washington State general fund. Impacts are assessed against trust lands in western Washington because of broadly similar operational and financial considerations with the analysis area.

How impacts are measured

Potential impacts to trust revenue, employment, and taxes are evaluated in this analysis. A threshold level of a 25 percent reduction in operable acres for most counties and trusts is used because it is assumed that counties can accommodate changes in revenue potential of this magnitude. This assumption is supported by the *Policy for Sustainable Forests*, which includes a policy that harvest levels not change by more than 25 percent from the preceding decade (DNR 2006, p. 25). This policy was approved by the Board of Natural Resources after SEPA review.

For Pacific and Wahkiakum counties, the threshold is set lower because Daniels 2004 identified these counties as "DNR counties of concern." Daniels states that these counties "may experience difficulty adapting to changes in DNR forest management strategies." Small reductions in revenue or employment in these counties is expected to have more impact on these counties than other counties.

The impact of the alternatives is expected to be adverse if the following criteria are met:

- Trust revenue:
  - For each trust except Pacific and Wahkiakum state forest trusts: operable acres available for harvest in western Washington in a trust decrease by more than 25 percent compared to Alternative A. A decrease of this magnitude is expected to result in a similar reduction in the long-term revenue generating capability of the trust lands.
  - Pacific and Wahkiakum state forest trusts: operable acres available for harvest in these trusts is lower than Alternative A based on the threshold established for this analysis.
- Employment:
  - Each county except Pacific and Wahkiakum counties: operable acres in western Washington in a county decrease by more than 25 percent compared to Alternative A.
  - Pacific and Wahkiakum counties: operable acres in these trusts is lower than Alternative A.
  - Western Washington: operable acres in western Washington decrease by more than 25 percent compared to Alternative A.

- Forest tax:
  - Each county except Pacific and Wahkiakum counties: operable acres in western Washington in a county decrease by more than 25 percent compared to Alternative A, and forest tax distributions to the county are equal to at least ten percent of the sales tax distribution.
  - Pacific and Wahkiakum counties: operable acres in these trusts is lower than Alternative A.
  - Western Washington: operable acres in western Washington decrease by more than 25 percent compared to Alternative A.
- Sales and other taxes:
  - There is a high uncertainty regarding the impact of the change in operable acres available for harvest on these tax revenues at the county level and state level.

Impacts less than the thresholds described in the preceding list are expected to be negligible.

Key assumptions

The analysis assumes that each operable acre can generate the same amount of timber volume in the same amount time and that the potential revenue of the timber is the same. In reality, site potential varies across the landscape. Due to the scale of the analysis and the spatial similarity between the alternatives, this difference is expected to be small. Harvest revenue depends on not only site potential, but also species composition, timber quality, management costs, operational difficulty, and availability of markets. For purposes of this generalized analysis, these factors are assumed to be similar between lands conserved under each alternative.

County-level employment change impacts assume that timber harvest volume is closely related to timber-job employment levels within a county. This assumption assumes that workers are not employed outside their home county.

Summary of direct, indirect, and cumulative impacts

Potential impacts to socioeconomics can be summarized under four general categories: trust revenue, tax revenue, employment, and environmental services and non-market values.

Trust revenue

The analysis provided here is designed to compare the proposed alternatives to one another. Assumptions are made about trust revenues in order to make this comparison. These assumptions cannot be carried through to a detailed analysis of local employment impacts or forest tax impacts, but some general conclusions can be reached. Assumptions are stated in the sections that follow. More accurate revenue estimates will be developed after a harvest schedule is determined (which is being developed under a new sustainable harvest calculation, currently in draft).[10]

IMPACTS TO TRUST REVENUE FROM TIMBER HARVEST

One way to assess the different strategies is to calculate the "bare land value"[11] of lands conserved or released by the different action alternatives as compared to Alternative A. This calculation assumes that the same prescription is applied to all lands affected by the alternative. The prescription assumes all the lands are higher-productivity sites and each operable acre is planted with Douglas fir, Western red cedar, or Western hemlock and is harvested in a variable retention harvest at age 50. Note that this calculation does not take into account the value of the standing timber on these lands. Not including the value of the standing timber in the bare land value calculations underestimates the impacts to trust revenue. However assumptions about the productively and rotation length overestimate the impacts if some areas have lower productivity, longer rotations, or lower harvest yields (refer to Appendix M).

Alternative B increases the number of operable acres available for harvest and therefore increases the bare land value of trust compared to Alternative A. Alternatives C, D, E, and F all reduce the operable acres. The impacts to the trust increase in this order: Alternative C, Alternative D, Alternative E, Alternative F (Table 4.11.1).

Table 4.11.1. Change in Management and Bare Land Value From Alternative A

	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Bare land value change	$26 million	-$12 million	-$13 million	-$15 million	-$61 million

Another way to assess the impact is to look at assumed annual value of timber sales that could have occurred in the conserved acres or that may occur in the released acres (Table 4.11.2). The analysis uses a similar set of assumptions. Specifically, the assumptions are that harvest volumes yield 32 thousand board feet per acre, that the sale price of the timber is $350 per thousand board feet, and that 1/50 of the operable acres are harvested each year.

[10] A DEIS for the sustainable harvest calculation is expected to be released December 2016.
[11] Bare land value (BLV) assesses the present net worth of an infinite number of successive, identical timber harvest rotations. As calculated here, the resulting value does not include any indication of the value of non-timber or non-market values. Revenue sources other than timber harvests could be included in the calculation, if applicable. BLV is calculated as: $BLV = \frac{NFW}{(1+i)^n - 1}$, where NFW is the net future worth calculated as the sum of the future revenue and costs of one rotation, with both revenue and costs compounded until the end of the rotation, i is the annual discount rate, and n is the number of years in a rotation. Note that this calculation assumes that the cost, revenue, and rotation length do not change over time.

Table 4.11.2. Change in Estimated Total Value of Timber Sales, by Action Alternative (assuming each operable acre yields 32 MBF per acre, that the sale price of the timber is $350 per MBF, and that 1/50 of the operable acres are harvested each year)

	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Timber sale value change	$4 million	-$2 million	-$2 million	-$2 million	-$9 million

CHANGES IN OPERABLE ACRES BY TRUST

For this analysis lands are grouped either by trust (for the federally granted lands) or by benefiting county (for the State Forestlands[12]). Tables 4.11.3 and 4.11.4 show the trusts where the operable acres in western Washington is significantly reduced. The impacts of the action alternatives to trusts and benefiting counties are as follows:

- **Alternative B:** No adverse impacts to any trust or trust and benefiting county combination. For all trust or trust and benefiting county combinations, the area with a full range of management options does not change or it increases compared to Alternative A.
- **Alternatives C through F:** Pacific County State Forest and Wahkiakum County State Forest trusts are adversely impacted.

Table 4.11.3. Change in Operable Acres Available for Harvest in the Federally Granted Trusts

		Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
	Trust(s)	Operable acres	% changes in acres available compared to Alternative A				
Federally granted trusts	Agricultural School Grant	10,436	1%	0%	0%	0%	-6%
	Capitol Building Grant	30,485	5%	-2%	-1%	-3%	-5%
	CEP&RI and CEP&RI transferred	30,485	2%	-2%	-3%	-2%	-4%
	Common School and Escheat	196,942	3%	-2%	-2%	-2%	-6%
	Normal School	10,157	5%	-4%	-4%	-5%	-2%
	Scientific School Grant	23,115	2%	-1%	-1%	-1%	-16%
	University Grant (original and transferred)	12,322	6%	-11%	-18%	-15%	-15%

[12] State Forest Purchase and State Forest Transfer Lands are combined for this analysis.

	Trust(s)	Alt. A (no action) Operable acres	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
			% changes in acres available compared to Alternative A				
Other lands	Community College Forest Reserve	2,401	0%	0%	0%	0%	-2%
	Community Forest Trust	0	0%	0%	0%	0%	0%
	Land Bank	0	0%	0%	0%	0%	0%
	Water Pollution Control Division Trust Land	3,820	0%	-2%	0%	-2%	0%
	Other	1,822	0%	0%	0%	0%	-2%

Table 4.11.4. Change in Operable Acres Available for Harvest in the State Forest Trust Lands (Transfer and Purchase), by County

State Forest Trust land	Alt. A (no action) Operable acres	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
		% changes in acres available compared to Alternative A				
Clallam County	39,752	10%	2%	3%	0%	6%
Cowlitz County	6,895	0%	0%	0%	0%	0%
Grays Harbor County	21,159	2%	2%	2%	2%	2%
Jefferson County	10,615	3%	2%	2%	2%	2%
King County	7,905	0%	-1%	0%	-1%	-0%
Kitsap County	4,036	0%	0%	0%	0%	0%
Lewis County	21,274	0%	0%	0%	0%	-5%
Mason County	18,004	0%	0%	0%	0%	0%
Pacific County	10,261	9%	-13%	-21%	-13%	-23%

State Forest Trust land	Alt. A (no action) Operable acres	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F
		% changes in acres available compared to Alternative A				
Pierce County	2,721	0%	0%	0%	0%	-11%
Skagit County	36,173	1%	-1%	0%	-1%	-2%
Snohomish County	33,984	1%	-2%	-1%	-2%	-2%
Thurston County	28,919	1%	1%	1%	1%	1%
Wahkiakum County	5,781	20%	-9%	-12%	-9%	-25%
Whatcom County	13,482	1%	-3%	-2%	-4%	-22%

Tax revenue

FOREST TAX

Changes in harvest levels have direct impacts on the annual forest tax liability of operators on trust lands. Harvest volume is expected to increase under Alternative B relative to Alterative A. Forest tax revenue will increase commensurately, assuming no change in the tax rate or timber value. Under Alternatives C, D and E, forest tax distributions from timber harvests on trust lands are expected to decrease significantly in Pacific and Wahkiakum counties based on the reduction in area available for harvest. The impact of Alternative D is expected to be greater on these counties than the impacts of Alternatives C or E.

Under Alternative F, forest tax distributions are expected to decrease significantly in Pacific and Wahkiakum counties. Pacific and Wahkiakum are more greatly impacted under this alternative than under Alternatives C, D, and E.

All alternatives have a negligible impact on the operable acres in western Washington trust lands subject to the forest tax. Therefore, impacts to the state of Washington general fund are expected to be negligible.

SALES AND OTHER STATE AND LOCAL TAXES

Counties and the state receive revenue from sales and other taxes. The revenue from these taxes depends on factors including the tax rate, population, employment, wages, expenditures made by visitors within the county and availability of retail outlets in a county, among other factors. Reduced harvest levels may reduce tax revenue by reducing employment and expenditures by businesses within a county. The impact of harvest reduction on tax revenue is expected to be greatest in counties where timber harvest is a larger component of the total economic activity in the county.

Pacific and Wahkiakum counties are more reliant on timber harvest than other counties in the analysis area. Alternative B is expected to increase harvest in these counties over the no action alternative and therefore result in increased tax revenue in these counties. Revenue is expected to fall in these counties under the other alternatives, with impacts increasing in the following order from smallest to greatest impact to revenue: Alternative C, E, D, F. However, the degree to which this may occur cannot be determined because the relationship between harvest levels and taxable sales and property values in the counties is not known.

Other counties are more economically diversified and less dependent on timber harvest. Any change in tax revenue due to any of the alternatives is expected to be relatively minimal in these counties compared to their large sales tax revenues. All alternatives have only a small effect relative to sales taxes from all economic activity in the state; therefore, impacts to the State of Washington general fund are expected to be minimal.

Tax revenue from economic activity on DNR-managed forestlands from sources other than timber harvest (for example, recreation) is not expected to change significantly under any action alternative. Any increases in tax revenue related to other land uses on DNR forestlands will likely be insufficient to replace tax revenues lost under Alternatives C through F.

Employment

Potential impacts to employment are measured based on the expected change to operable acres. For all western Washington counties together, the change in operable acres available ranges from an increase of 3 percent under Alternative B to a decrease of 4 percent under Alternative F (Table 4.11.5).

Table 4.11.5. Change in Operable Acres in Western Washington, Compared to Alternative A

	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Change in operable acres (percent)	17,404 (3%)	-7,979 (-1%)	-8,680 (-1%)	-10,420 (-2%)	-26,000 (-4%)

The harvest level is expected to increase relative to Alterative A (no action) under Alternative B. Employment may increase commensurately, if only slightly. Harvest levels are expected to fall under Alternatives C through F. Adverse impacts are therefore expected in Pacific and Wahkiakum counties under Alternatives C through F. The impact of Alternative D to Pacific and Wahkiakum counties is expected to be greater on these counties than either Alternative C or E but less than the impact of Alternative F. Declines in employment in these counties could be locally mitigated if the alternative results in more acres of thinning harvest because thinning requires more labor per unit of volume to harvest (Mason and Lippke 2007). The overall acres subject to thinning will, however, be less than what was available for variable retention harvest.

Environmental services and non-market values

CARBON SEQUESTRATION

All the alternatives are expected to increase the amount of carbon sequestered on state trust lands over the life of the HCP (refer to Chapter 4.1, Climate). The action alternatives were ranked in that section from most to least carbon sequestration, in order as Alternative F, E, C, D, and then B. However, the amount sequestered under any of these alternatives is not known, and the value cannot be calculated. As no marbled murrelet conservation strategy alternative proposes the sale of carbon credits, no revenue is expected to be generated for the trusts by carbon sequestration.

OTHER NON-TIMBER LAND USES

It is uncertain how the action alternatives will change how people would value non-timber social, environmental, and economic resources. However, because the action alternatives are designed to support the long-term survival of the marbled murrelet, a neutral or positive valuation is expected.

The analysis of impacts to recreation (refer to Chapter 4.7, Recreation) shows that the action alternatives do not have a measurable negative impact on recreation in the analysis area. For mining and other leases, the action alternatives may reduce land available for new activities, but no immediate impacts to planned leases or easements are known since known locations for these leases are far from occupied sites.

The conservation measures associated with the action alternatives do not preclude collection of non-timber forest products. Small changes to the annual harvest area and area of closed canopy forest are likely to occur under the action alternatives in the analysis area. These changes will not significantly lessen the availability of non-timber forest products collected on trust lands. Therefore, no significant impacts to trust revenue or the public's economic well-being due to effects of any of the marbled murrelet long-term conservation strategy on the collection of non-timber forest products is expected.

Cumulative effects

Alternative B, by increasing the number of operable acres available for harvest as compared with Alternative A, is expected to result in stable or increased harvests levels on all trusts and in all counties in the analysis area, stable or increased revenue for all trust beneficiaries with lands within the analysis area, and stable or increased tax revenue and employment in counties within the analysis area.

Alternatives C through F, by decreasing the number of operable acres available for harvest, are expected to result in stable or decreased harvest levels on most trusts and in all counties in the analysis area, stable or decreased revenue for most trust beneficiaries with lands within the analysis area, and stable or decreased tax revenue and employment in counties within the analysis area. Revenue from State Forest trust lands is distributed in accordance with RCW 79.64.110. DNR generates the revenue and distributes it to the counties in which the land is located. Counties further distribute funds to taxing districts and local services; therefore, reduced revenues expected under these alternatives could impact these services.

Pacific and Wahkiakum counties are adversely impacted by Alternatives C through F. Under these alternatives, these two counties can expect reduced revenue and employment based on the thresholds established for this analysis. Because these counties currently have low socioeconomic resiliency, below average economic diversity, and are more heavily dependent on timber harvest for local government revenue, the economies of these counties are less able to tolerate a reduction in harvest volume than other counties.

Uncertainty

The distribution of marbled murrelet conservation areas results in a highly fragmented landscape of potentially operable (harvestable) acres. This variability may result in constraints on forest management activities that are otherwise authorized because of operational costs or inaccessibility (for example, if a harvestable stand is located on the other side of a large block of marbled murrelet conservation). Depending on the frequency of this occurrence, the potential for decreased revenue under Alternatives C through F could be lower or higher than anticipated here. Likewise, Alternative B may not yield the expected increase in revenue compared to Alternative A.

Table 4.11.1. Summary of Potential Impacts to Socioeconomics

Key questions	Criteria	Measures	Potential impacts
How do the alternatives affect trust revenue over the life of the HCP?	Operable acres available	Change in operable acres—reduction in operable acres by over 25% considered adverse	Overall decreased trust revenue. This impact is adverse for the Pacific County State Forest and Wahkiakum County State Forest trusts under Alternatives C through F. .
How do the alternatives affect county and state government revenue from other sources over the life of the HCP?	Operable acres available	Change in operable acres	Overall decreased trust revenue. This impact is likely adverse for Pacific and Wahkiakum counties under Alternatives C through F.
How do the alternatives affect county employment levels over the life of the HCP?	Operable acres available	Change in operable acres Portion (%) of county in harvest-related employment	Decreased employment is possible in Pacific and Wahkiakum counties under Alternatives C through F.
How do the alternatives affect environmental services and non-timber economic activities over the life of the HCP?	Opportunities available	Change in opportunities	No measurable impacts identified.

Potential mitigation for adverse impacts

The legislature has authorized the transfer or disposition of certain state trust lands encumbered with long-term deferrals due to Endangered Species Act-listed species. Encumbered State Forest Lands in counties with a population of 25,000 or less, which includes Pacific and Wahkiakum counties,[13] may be transferred into Natural Resource Conservation Areas (Washington Department of Natural Resources 2013, RCW 79.22.060, 79.22.140.). The transfer requires compensation at fair market value without consideration of the endangered species encumbrances. The counties' beneficiaries receive the appraised timber value, less a management fee, at the time of transfer while the land value must be used to purchase replacement State Forest Lands that can generate revenue.

[13] The State Forest Replacement Lands Program also applies to Skamania and Klickitat counties, which are outside the analysis area.

4.12 Cultural and Historic Resources

This section considers whether any of the alternatives would unintentionally affect cultural resources.

Analysis questions

The primary questions addressed regarding cultural resources are the following:

- *Do cultural and historic sites remain protected under the action alternatives?*
- *How would access to cultural resources be affected by the action alternatives?*
- *How would traditional cultural materials and foods, such as fish, wildlife, and plants, be affected by the action alternatives?*

Evaluation criteria

The primary criterion for cultural and historic resources is that significant sites, access, or materials would not be damaged or destroyed as a result of the alternatives.

Scale of analysis

Effects on cultural resources are considered at the programmatic level for the entire analysis area.

How impacts are measured

Impacts will be measured based on a qualitative review of the potential for actions considered in the alternatives to adversely affect cultural and historic resources.

Summary of direct, indirect, and cumulative impacts

No significant impacts to cultural and historic resources are anticipated under any of the action alternatives. These resources are typically identified by DNR and protected as part of project planning for timber sales and other forest management activities such as construction of recreational trails or communication sites.

Site protection

Pelton wheel, used to power historic mines in DNR's Northwest region. Photo: DNR

The primary threat to cultural and historic sites is timber harvest and associated road construction and subsequent public access and uses. All action alternatives include measures restricting timber harvest in LTFC and limiting road construction and new recreational facility development in marbled murrelet conservation areas. Alternatives C through F increase the total amount of LTFC compared with the action alternative. Alternative B, while resulting in fewer total acres of LTFC, adds 16,000 acres of occupied sites where harvest would be prohibited.

All action alternatives would also make some currently deferred lands available for potential harvest (refer to Chapter 2, Figure 2.4.1). Alternatives C through F would remove LTFC designation from 2,000 to 3,000 acres in the Straits planning unit only, while Alternative B would remove LTFC designation from approximately 27,000 acres in the analysis area (most in OESF). While this could result in more access to currently unidentified or inaccessible cultural and historic sites within these areas, potential impacts would be addressed under the current regulatory framework at the project-specific level. Existing DNR cultural resource protection procedures would be expected to identify and avoid significant adverse impacts from harvesting stands that are currently deferred under the interim strategy.

Access

Ongoing Tribal access and use of DNR lands for collection of traditional cultural materials and food (for example, cedar bark, bear grass, and berries) is not limited under the proposed action alternatives. This type of access is typically coordinated via consultation with regional staff or DNR’s tribal liaison office, and this process would be unchanged under a long-term strategy. Where existing roads may be abandoned in proposed marbled murrelet conservation areas, it is possible that some local access issues could occur. It is expected that the existing tribal consultation practices would continue to address site-specific access issues.

Traditional cultural materials and foods

Forest stand conditions would be altered over time within lands designated as LTFC, and these changes are likely to alter the abundance and availability of certain traditional materials. Some, such as cedar wood and bark, may increase within LTFC, while others, such as berries, may decrease within areas of mature and maturing forest. However, while localized changes in habitat conditions may temporarily reduce forage for important species such as deer and elk within LTFC, overall abundance and distribution of culturally important species and other traditional materials would likely remain stable or increase on state trust lands (refer to Section 4.5, Wildlife).

Conclusions

The alternatives are focused on varying levels of LTFC for marbled murrelet conservation purposes, and none of the alternatives would result in direct harm to any cultural resources. Effects that may occur later in time, as projects are implemented under the strategic direction established in the alternative selected, would be addressed through DNR's existing archaeological assessment work and tribal consultation. The effects identified are not sufficiently significant to contribute to cumulative effects related to cultural and historic resources.

Table 4.12.1. Summary of Potential Impacts to Cultural and Historic Resources

Key questions	Criteria	Measures	Potential impacts
Do cultural and historic sites remain protected by the alternatives?	Significant historic, archaeological, and cultural sites would not be damaged or destroyed.	Qualitative	None. Effects are addressed at the project-specific level (e.g., plans for specific thinning operations).
How would access to cultural resources be affected by the alternatives?	Tribal access to the forest would not be lost.	Qualitative	Some existing roads may be abandoned where they are located within marbled murrelet conservation areas under all action alternatives, which could interfere with access to some areas. In areas where access is currently limited under Alternative A, some new roads may be built under the action alternatives, which could increase public access to tribal use areas and/or physically harm unknown cultural or historic sites. However, road locations are assessed for cultural and historic resource impacts at the project-specific level prior to construction, so there is not expected to be damage to cultural or historic sites.
How would traditional cultural materials and foods, such as fish, wildlife, and plants, be affected by the alternatives?	Supplies of culturally important resources would not be lost.	Qualitative	Changes in habitat conditions over time in LTFC may locally reduce forage habitat for some game species, but overall abundance and distribution of species would remain stable or increase on state trust lands (refer to Section 4.8, Wildlife). Fish resources are not expected to be impacted (refer to Section 4.4, Aquatic Resources).

Chapter 5

CUMULATIVE EFFECTS

Chapter 5

Cumulative Effects

This chapter describes potential cumulative effects of the alternatives, with a focus on how the alternatives relate to other past, present, and future actions that affect elements of the environment.

■ Guidance on assessing cumulative effects

Analysis of cumulative impacts can provide more information to advance agency decision making, including the consideration and comparison of significant adverse impacts for all reasonable alternatives.[1] NEPA and SEPA rules require analysis of cumulative impacts. Council on Environmental Quality (CEQ) regulations include the following definitions and requirements for cumulative effects:

- 40 C.F.R §1508.7 defines cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."
- 40 C.F.R. §1508.25 identifies "cumulative actions" as "actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement." Section §1508.25 also defines that the scope of impacts to be considered in a NEPA document includes direct, indirect, and cumulative impacts.
- 40 C.F.R. §1508.27 specifies that cumulative impacts are one of ten key intensity factors federal agencies must consider in determining the significance of adverse impacts of their actions.

Under Washington State SEPA rules, the scope of impacts analyzed in an EIS includes cumulative impacts (WAC 197-11-060(4)(e); 197-11-792).

■ Evaluation criteria

Two main questions are used in this chapter to analyze potential cumulative effects:

- *Would the alternatives involve individually minor but collectively significant actions taking place over a period of time?*
- *Would the incremental impacts of the alternatives—when added to other past, present, and reasonably foreseeable future actions—result in significant adverse effects?*

[1] Refer to *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997), a handbook providing a framework for advancing environmental impact analysis by addressing cumulative effects.

An action cannot contribute to a cumulative effect on any particular element of the environment if the action does not have any direct or indirect impacts on that element of the environment. Therefore, a primary criterion for determining cumulative effects is whether any individual adverse impacts have been identified for the specific elements of the environment included in the scope of this DEIS. Another criterion is the total acres of long-term forest cover (LTFC) conserved under each alternative.

Individually minor but collectively significant actions

All action alternatives would establish new designations of marbled murrelet conservation areas, apply new conservation measures, and release some lands for harvest. The underlying regulatory and policy framework governing the management of these DNR forestlands would remain largely unchanged, but the addition or subtraction of acres in murrelet conservation or the change in management of specific conservation areas could cause cumulative effects. Chapter 4 of this DEIS includes analyses of whether these individual changes could be collectively significant for an element of the environment over the entire analysis area and over an extended planning period.

■ Forest management in the analysis area: Past, present, and future trends

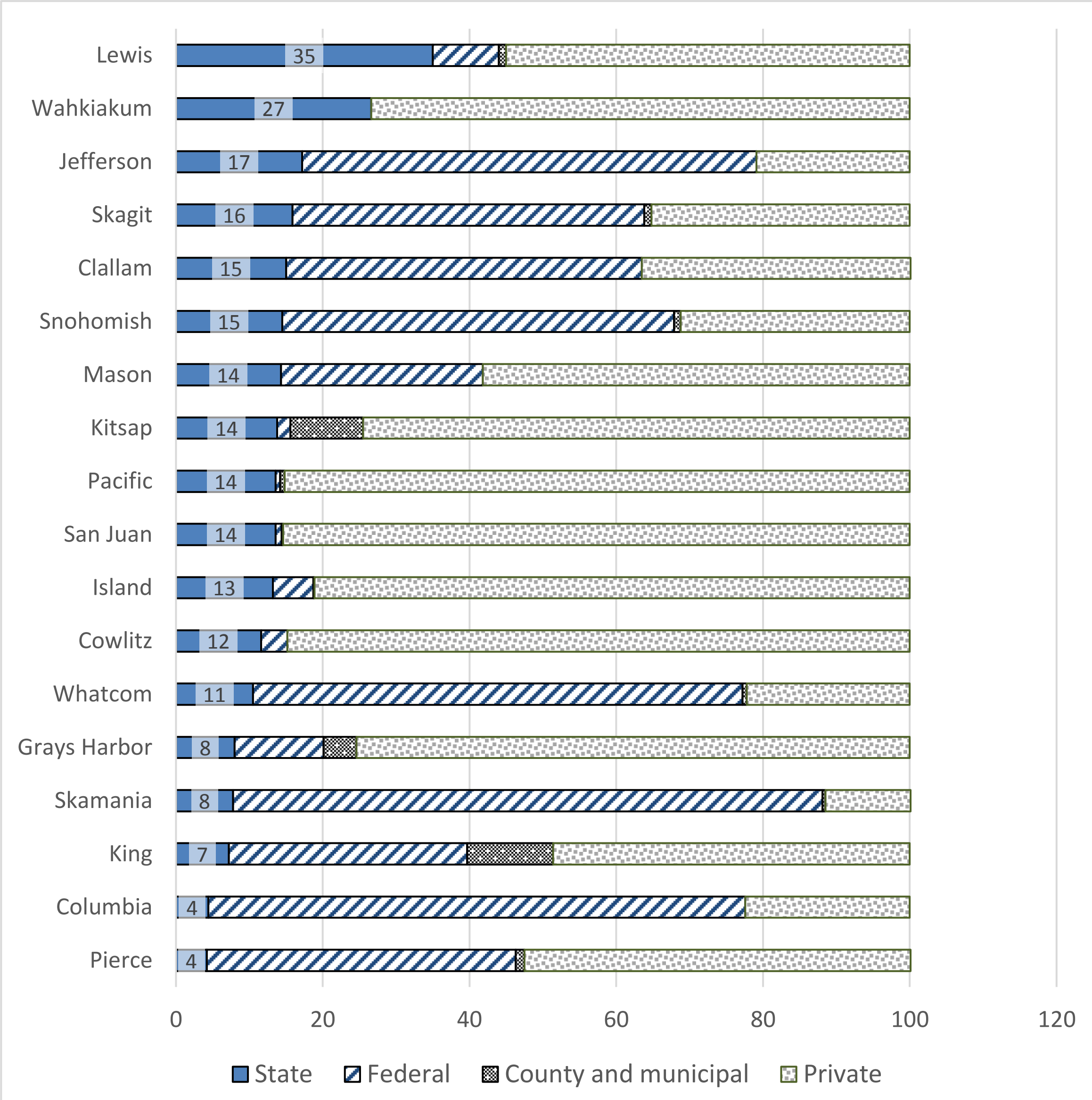
Forestland ownership context

An important aspect of cumulative effects is the mix of land ownership within the landscapes upon which cumulative effects may occur. Within the approximately 13.5-million-acre analysis area (terrestrial lands within 55 miles of the marine waters), 31 percent are federal lands (primarily National Forest and National Park), 9 percent are managed by DNR, and approximately 60 percent of the lands are in other non-federal ownership.

Based on acreages presented by Daniels 2004, private lands make up more than half of forestlands within Lewis, San Juan, Pacific, Cowlitz, Island, Grays Harbor, Kitsap, Wahkiakum, Mason, and Pierce counties, and federal lands make up more than half of the forestlands within Whatcom, Jefferson, and Snohomish counties.

Figure 5.1.1 breaks out the acres of land ownership by county (Daniels 2004).

Figure 5.1.1. Proportion of State Trust and Other Forestland Ownership Within Analysis Area, by County[a]



[a] Numeric percentages shown for state trust lands only. Portions evaluated based on entire county land base (not just within analysis area). Source: Daniels 2004.

Effects of past forest management on the marbled murrelet[2]

Historically, habitat has been lost throughout the range of the marbled murrelet, largely due to timber harvest and some due to fire and other stochastic events. Section 4.6 described in detail the trends in population decline of the marbled murrelet in Washington and projects how the alternatives might affect that trend. Regional trends and other impacts from outside the analysis area or the scope of the proposed action are summarized here.

PAST HABITAT LOSS THROUGHOUT THE RANGE OF THE MARBLED MURRELET

The loss of nesting habitat was a major cause of marbled murrelet population declines over the past century and may still be contributing as nesting habitat continues to be lost to fires, logging, and wind storms (Falxa and Raphael 2016). The Northwest Forest Plan (NWFP) effectiveness monitoring program set out to identify and map murrelet habitat across California, Oregon, and Washington and estimate changes in habitat amount, distribution, and quality over time. The model estimated 2.53 million acres of habitat across the plan area in 1993, the start of the NWFP. Across the plan area, approximately 59 percent of all habitat was on federal lands. The plan-wide habitat estimate was 2.23 million acres in 2012, representing a net loss of 12 percent (Raphael and others 2015a). Habitat loss was greater on non-federal lands, a net 27 percent loss over twenty years due to wildfire, timber harvest, wind blowdown, and debris flows. A net habitat loss was observed on federal lands as well, approximately 2 percent overall with most loss due to fire and other natural disturbances. Currently, only about 12 percent of the habitat-capable lands within the listed range of the marbled murrelet contain nesting habitat (Falxa and Raphael 2016).

Murrelet population size and distribution is strongly correlated between stands of cohesive and higher suitability nesting habitat (Falxa and Raphael 2016). The largest marbled murrelet subpopulations now occur off the coast of Oregon and northern California, while subpopulations in Washington have experienced the greatest rates of decline. Rates of nesting habitat loss have also been highest in Washington due to the wildfire, timber harvest, wind blowdown, and debris flows on non-federal lands (Falxa and Raphael 2016), which suggests that the loss of nesting habitat continues to be an important limiting factor for the recovery of murrelets. While conservation of suitable nesting habitat is vital to murrelet conservation, marine conditions, which contribute to murrelet prey abundance, likely influence murrelet distribution and population trends. The 20-year monitoring report for the NWFP notes that conservation of the marbled murrelet will not be possible if trends in habitat loss continue at the rates estimated over the past 20 years (Falxa and Raphael 2016).

[2] CEQ's cumulative effects guidance recommends "analysis and a concise description of the identifiable present effects of past actions to the extent that they are relevant and useful in analyzing whether the reasonably foreseeable effects of the [proposed action] and its alternatives may have a continuing, additive and significant relationship to those effects." (*Guidance on the Consideration of Past Actions in Cumulative Effects Analysis* (CEQ 2005)).

PAST FOREST MANAGEMENT ON STATE TRUST LANDS

Throughout much of the 20th century, timber management on state trust lands was primarily focused on clearcut harvesting of structurally and biologically diverse stands and converting them into even-aged young stands dominated by Douglas fir. For some time, DNR policy was to harvest the oldest stands first (DNR 1979). In many cases, harvested stands were broadcast burned and planted to Douglas fir, which rapidly became densely stocked with little understory vegetation or structural complexity. As a result, most of the DNR-managed lands have been managed for timber production, resulting in potential loss marbled murrelet nesting habitat prior to the listing of the marbled murrelet as a threatened species in 1992.

DNR-managed lands in the analysis area encompass over 1.37 million acres and represent about 9 percent of the total land area within the range of the marbled murrelet in Washington. While much of this area is conserved in LTFC, only about 213,000 acres is currently classified as marbled murrelet nesting habitat, representing about 15.5 percent of the DNR-managed lands and about 14 percent of the total estimated marbled murrelet nesting habitat in Washington. The USFWS recovery plan for marbled murrelet (USFWS 1997) considers nesting habitat on state-managed lands as essential for the conservation and recovery of murrelets, particularly in landscapes that have little or no federal lands.

The 1997 HCP established landscape-level strategies to support endangered species conservation on state trust lands through a combination of active and passive habitat management. These 1997 HCP strategies also increased protection of riparian and northern spotted owl habitat, which supports murrelet nesting habitat. Since signing the 1997 HCP, DNR has also increased the acres of protected natural areas (NAPs and NRCAs) and increased protection of old growth.

Management for marbled murrelets under the 1997 HCP has occurred under an interim strategy that focused on identifying marbled murrelet nesting habitat and generally avoiding timber harvest in areas deemed likely to be occupied by marbled murrelets. Since signing the 1997 HCP, DNR has also established marbled murrelet habitat protection measures in the North and South Puget planning units and restricted harvests in southwest Washington. As a result, DNR established protections of habitat across approximately 190,000 acres within the analysis area, which dramatically reduced the harvest-related loss of habitat on DNR-managed lands to only the lowest-quality habitat.

The interim strategy authorized the removal of low-quality (“marginal”) marbled murrelet habitat that would be expected to contain a maximum of 5 percent of potential occupied sites (DNR 1997, p. IV.40, Step 3) and allowed for some harvest of habitat that was surveyed but determined to be unoccupied (DNR 1997, p. IV.40, Step 4). To date, approximately 26,300 acres of marginal habitat and 2,600 acres of surveyed unoccupied habitat have been harvested (approximately 29 percent of low-quality habitat on DNR-managed land).

Additionally, natural disturbance events, including the “Great Coastal Gale of 2007,” resulted in a loss of marbled murrelet habitat, and salvage activities have occurred on approximately 1,200 acres of windthrow-damaged murrelet habitat throughout the analysis area. While most marbled murrelet nesting habitat has been retained on state lands since 1997, timber management in intervening areas may have fragmented remaining habitat patches and contributed to edge effects.

PAST MANAGEMENT OF FEDERAL LANDS

Federal lands within the range of the marbled murrelet in Washington include National Parks and National Forests, as well as smaller areas associated with National Wildlife Refuges and Department of Defense military reservations. As with state-managed lands, much of the historic marbled murrelet nesting habitat that existed on federal lands outside of the National Parks was lost to timber harvest prior to the listing of the marbled murrelet as a threatened species in 1992 (USFWS 1997). As a result, large areas of the National Forest lands now contain densely stocked tree plantations rather than naturally functioning forest, and much of the remaining old-forest habitat is highly fragmented (Falxa and Raphael 2016). Federal lands in the analysis area encompass over 4.2 million acres and represent about 31 percent of the total land area within the range of the marbled murrelet in Washington. Current estimates indicate over 887,000 acres of marbled murrelet nesting habitat occur on federal lands, which represent about 66 percent of the total estimated marbled murrelet nesting habitat remaining in Washington. Currently, about 26 percent of the habitat-capable area on federal lands contains murrelet nesting habitat (Falxa and Raphael 2016).

The 1994 Northwest Forest Plan (USFS 1994) established a large network of late-successional reserves on National Forest lands for the specific purpose of maintaining and recruiting late-successional and old-growth forests. These areas along with National Parks and designated Wilderness areas are all considered federal reserves. In Washington, nearly 90 percent of federal lands within the range of the marbled murrelet are in federal reserves. Federal reserves are expected to provide the primary role for the conservation and recovery of the marbled murrelet in most areas (USFWS 1997). Nesting habitat in conservation reserves on federal lands is expected to increase over the next 50 years as young forests transition to more mature forests and the quality of existing habitat increases through a reduction of past habitat fragmentation and edge effects.

Under the Northwest Forest Plan, the focus of forest management on National Forests has shifted from regeneration timber harvest to ecological restoration. Examples of recently planned projects within the analysis area are the Queets Vegetation Management Project on the Olympic National Forest (USFS 2015a) and the Hansen Creek Vegetation Project on the Mount Baker Snoqualmie National Forest (USFS 2015b). The Queets project is located adjacent to lands proposed for marbled murrelet conservation in DNR’s long-term murrelet conservation strategy alternatives in the Upper Clearwater and Queets landscape units.

PAST MANAGEMENT OF PRIVATE FORESTLANDS

Private industrial forestlands are intensively managed and typically have trees less than 60 years old. Very few late-stage forests are present on such lands and most stands are less than 50 years old. Private industrial forestlands are focused on timber production, with many areas being harvested on relatively short rotations (in the range of 40 to 50 years) (Davies and others 2011). Private forestlands within the analysis area are also being converted to other uses, including industrial and residential developments.[3]

[3] Refer to http://file.dnr.wa.gov/publications/em_fwflanduse.pdf.

Private forestlands (industrial and non-industrial private lands) in the analysis area encompass over 6 million acres of habitat-capable lands within the range of the marbled murrelet in Washington. Current estimates indicate over 260,000 acres of marbled murrelet nesting habitat occur on private lands, which represents about 20 percent of the total estimated marbled murrelet nesting habitat remaining in Washington. Most habitat remaining on private lands is highly fragmented and occurs in small, scattered patches. Currently, only about 4 percent of the habitat-capable area on private lands contains marbled murrelet nesting habitat (Falxa and Raphael 2016).

Private timber harvest in Washington must comply with the Washington Forest Practices Act (RCW 76.09) as well as the Washington Forest Practices Rules (WAC 222), although the requirements could vary if the landowner has a federally approved HCP. Washington forest practices rules require murrelet surveys in habitat as defined in WAC-222-16-010 and provide protection for known occupied and presumed to be occupied marbled murrelet habitat until it is shown not to support murrelets.

Monitoring for the Northwest Forest Plan indicates that potential marbled murrelet nesting habitat on non-federal lands (state, private, tribal, and county ownerships) in Washington has declined over the past 20 years from wildfire, timber harvest, and other natural disturbances (Falxa and Raphael 2016). It is important to note that estimates of potential marbled murrelet nesting habitat identified through remote sensing models are not directly comparable to field-based habitat delineations required under the Washington forest practices rules. However, habitat models derived from remote-sensing data indicate that most of the potential marbled murrelet nesting habitat on private lands is now largely confined to areas associated with known occupied marbled murrelet sites, riparian corridors, unstable slopes, and other areas deferred from harvest through existing HCPs or other deferrals under the Washington forest practices rules.

Present and potential future actions and threats to marbled murrelets

This section considers the present and reasonably foreseeable future actions that may influence the marbled murrelet population in Washington State. Based on a 2012 review of the species status by a USFWS recovery implementation team (USFWS 2012) and other recent USFWS analyses, known and potential cumulative effects on marbled murrelets in addition to loss of nesting habitat and predation include:

- Changes in marine forage conditions, affecting the abundance, distribution, and quality of murrelet prey
- Post-fledging mortality from oil spills, fisheries bycatch, derelict fishing gear, and wind energy projects
- Cumulative and interactive effects of factors on individuals, populations, and the species.

In a 2010 finding regarding a petition to delist the marbled murrelet (USFWS 2010), the USFWS determined that it was reasonable to expect that the species will continue to be exposed to a broad range of threats across its listed range. Although some threats have been reduced, most continue unabated and new threats now strain the ability of the murrelet to successfully reproduce. In the 2010 finding, the USFWS concluded that reproductive success was too low to sustain the population and that manmade and natural threats were likely to continue at current or increased levels, resulting in the population continuing to decline.

It is important to note that this DEIS does not determine whether the alternatives would "jeopardize the continued existence" of the Washington/Oregon/California distinct population segment of the marbled murrelet. Once DNR submits an application based on an alternative for an amendment to its incidental take permit, USFWS prepares a biological opinion to determine whether the final strategy would "cause jeopardy" to the species. Cumulative effects of the action alternatives will be key factors the USFWS will consider when making determinations regarding jeopardy. Population viability analyses conducted for the proposed alternatives will be informative to these determinations (refer to Section 4.6 and Appendix C).

CHANGES IN LONG-TERM FOREST COVER

The no action alternative would continue to protect marbled murrelet habitat designated under the interim strategy, and more habitat would develop in long-term forest cover. The changes to LTFC brought by the action alternatives are follows:

- Alternative B would reduce LTFC by approximately 27,000 acres (2 percent of total DNR-managed lands within the analysis area).
- Alternative C would increase LTFC by approximately 16,000 acres (1.2 percent).
- Alternative D would increase LTFC by approximately 13,900 acres (1.0 percent).
- Alternative E would increase LTFC by approximately 20,300 acres (1.5 percent).
- Alternative F would increase LTFC by approximately 113,000 acres (8.2 percent).

The cumulative amount of lands where LTFC would be designated would change from the current 45 percent under Alternative A to 43 percent under Alternative B, approximately 46 percent under Alternatives C, D, and E, and 54 percent under Alternative F. The cumulative result of an increase in LTFC over time would be an increase in structurally complex forest within these acres, a decrease in available timber volume for harvest in these areas, and a potential shift in other forestland uses (such as recreation, leases, and road building) to other areas of the forest. With Alternative B, the cumulative effect of a decrease in LTFC would mean an increase in available timber volume and fewer impacts to other non-harvest land uses. These incremental changes can be analyzed in the context of other actions, trends, and activities affecting elements of the environment in the analysis area in order to determine their significance.

FUTURE FOREST MANAGEMENT WITHIN THE ANALYSIS AREA

On private forestlands in Washington, commercial forest management is expected to continue on a rotation schedule of 40 to 50 years. This short rotation schedule is not expected to grow into marbled murrelet habitat. Riparian zones are managed differently than the uplands, and over long durations, and in some cases habitat may develop in limited areas. However, due to their narrow width, riparian zones are not expected to develop extensive areas of habitat, nor is that habitat expected to provide secure areas for marbled murrelet nesting (refer to Section 4.6 and Appendix H for discussion of edge effects) due to the short rotation in the adjacent uplands.

National Forests are expected to provide increasing amounts of habitat into the future. In Washington, nearly 90 % of federal lands within the range of the marbled murrelet are in federal reserves. Federal reserves are expected to provide the primary role for the conservation and recovery of the marbled murrelet (USFWS 1997) in most areas. Nesting habitat in conservation reserves on federal lands is expected to increase over the next 50 years as young forests transition to more mature forests, and as the quality of existing habitat increases through a reduction of habitat fragmentation and edge effects. The U.S. Forest Service is intentionally managing for older forests, which will benefit the marbled murrelet into the future. If management for late-successional and old-growth forests continues, there will be substantial increases in habitat amount and quality on Federal lands. Current estimates indicate over 1.5 million acres on Federal lands in Washington are young forests (43%) that are habitat capable (Falxa and Raphael 2016). Much of this forest is likely to transition into habitat over next 50 to 100 years. National Parks within the range of the murrelet are expected to continue providing high quality habitat for the species.

FOREST CONVERSION

The Washington state population grew 1.34 percent in 2015 to 7,061,400 residents (www.ofm.wa.gov/pop/april1/poptrends.pdf). This population growth contributes to forestland conversion for homes and businesses. While these land conversions are probably not harvesting much habitat for marbled murrelets, in some landscapes, forest conversions are happening close to habitat, for example near Port Angeles. When this happens, it reduces the effectiveness of the existing habitat for murrelets, in one way by providing enhanced habitat for corvids. Section 4.6 describes these types of effects. The population of Washington is expected to continue to grow and with it, the continuance of forestland conversion, which can result in reduced habitat effectiveness.

WASHINGTON STATE MARBLED MURRELET LISTING

A periodic status review on the marbled murrelet in Washington by the Washington Department of Fish and Wildlife is currently being undertaken by the State Fish and Wildlife Commission to change the listing from state threatened to state endangered. This decision will likely be made during this NEPA review period. This may prompt a state recovery plan, which could provide guidance on recovery efforts at the state level.

CLIMATE CHANGE

Within the planning period of this DEIS, it is unlikely that the conservation approaches proposed under the alternatives will exacerbate expected climate change impacts (refer to Section 4.2). However, climate change is expected to alter forest ecosystems throughout the range of the marbled murrelet (Kliejunas and others 2008), potentially negatively impacting habitat for many species, including the murrelet (USFWS 2011). Climate change is likely to increase threats to the marbled murrelet throughout its inland range, such as the projected drought-related fire, mortality, insects and disease, and increases in extreme flooding, landslides, and windthrow events in the next 10 to 30 years. While it appears likely that the marbled murrelet will be negatively affected by these changes, USFWS has determined that it lacks sufficient information to quantify the magnitude of effects to the species from climate change projections.

Climate change is also expected to alter marine conditions in ways that could harm marbled murrelets' primary foraging habitat, including harmful algal blooms, dead zones, and reduced prey availability and quality. The ability of the species to respond to shifts in prey conditions is constrained by several factors. Nesting habitat distribution is limited, and nesting birds may be restricted to foraging in waters relatively near their inland nest sites (USFWS 2009, p. 14).

■ Incremental impacts of the alternatives

This section examines whether the alternatives—when added to other past, present, and reasonably foreseeable future actions—could result in collectively significant cumulative impacts to marbled murrelet habitat or other elements of the environment.

Incremental impacts—marbled murrelets

All alternatives will result in both short-term losses of existing nesting habitat and long-term increases in habitat in areas conserved as LTFC. Depending on the alternative, habitat losses balanced with habitat gains on DNR lands are projected to result in a net increase from the current level of 213,000 acres (15.5 percent) to over 316,000 acres of nesting habitat (23 percent to 27 percent) over the next 50 years.

Alternative B represents the greatest risk for negative cumulative effects to marbled murrelets because it would remove the greatest amount of existing habitat (49,000 acres, including over 8,600 acres of higher-quality habitat). This represents approximately 4 percent of the total habitat in Washington State (Falxa and Raphael 2016). It does not provide buffers associated with occupied sites, so the chance of sites persisting are likely to be reduced by edge effects. Habitat gains in LTFC eventually outweigh habitat losses, but it will take 3 to 4 decades for habitat gains to be realized.

Alternatives C through F all have potential to provide positive cumulative effects by conserving existing habitat and recruiting additional habitat in key landscapes that are essential for the conservation and recovery of marbled murrelets. Alternative F has the greatest potential to contribute toward reversing or restricting the decline of the marbled murrelet population because it would remove the least amount of habitat outside LTFC, provide the most acres of LTFC, and is likely to result in substantial increases in nesting habitat in key landscapes over the next 5 decades (for example, in southwest Washington).

The incremental effect of the long-term conservation strategies on marbled murrelet would be limited to incidental take if through this process an amended incidental take permit is issued by USFWS. This take would likely include harvest of murrelet habitat in areas outside LTFC, take from some limited road construction and maintenance in certain occupied sites, and take from edge impacts, roads, and disturbance from forest management and land use within LTFC. The alternatives would variously minimize take through conservation of habitat in long-term forest cover and mitigate take by the growth of P-stage habitat, softening of edge effects over time, and conservation measures that reduce disturbance and road impacts. Provided that forest growth occurs as projected, the resulting impact and mitigation analysis shows that mitigation exceeds take for all alternatives except Alternative B.

Given the declining murrelet population trend in Washington, it is uncertain whether the murrelet population will respond to increased habitat on federal or state lands in the future under any alternative. Because murrelet population trend has been linked to trends in nesting habitat, minimizing the loss of the nesting habitat and recruiting additional high-quality habitat are necessary to minimize future declines. All the alternatives include impacts to marbled murrelets, including removal of habitat and other impacting actions. The alternatives have varying levels of conservation intended to minimize and mitigate timber harvest and other impacts. Considering the threats to the species (refer to preceding sections) there is increased risk to the species from the alternatives if the intended conservation does not perform as expected. For example, Alternative B has the most timber harvest and least conservation; thus, there is a higher risk of this alternative having cumulative impacts in comparison to the other alternatives.

Results of population models show, under one modeling scenario, a reduction or reversal in the rate of decline of the DNR modeled population (refer to Section 4.6). Alternatives with a greater loss of higher-quality habitat have a greater potential negative impact to the modeled marbled murrelet population. However, cumulative ongoing impacts from other stressors in the marine and terrestrial environments that are outside the scope or control of the proposed action may also be contributing to ongoing population decline.

Incremental impacts—non-forest land uses

The existing underlying policy and regulatory framework governing forest management remains largely unchanged under the action alternatives. Alternative B would increase land available for harvest compared with the no action alternative; all other alternatives decrease land available for harvest. Impacts of these existing policies and regulations, including harvest impacts, have been previously analyzed.[4]

Alternatives C, D, E, and F would increase lands conserved for marbled murrelet, and while this largely has neutral or beneficial impacts to other elements of the environment, some minor to moderate adverse effects can be identified for road networks and associated recreational opportunities or development of other non-forestland uses (such as mineral extraction and telecommunications). Reductions in area available for non-forest land uses could shift demand to elsewhere within the range of the marbled murrelet; however, existing uses would remain unchanged. Future recreational or leasing demands for state trust lands would be managed at the tactical level through forest land plans and at the operational level for project-specific facilities and plans.

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[4] Refer to *Final Environmental Impact Statement for the Alternatives for Sustainable Forest Management of State Trust Lands in Western Washington* (DNR 2004, 2007); *Final (Merged) Environmental Impact Statement for the Habitat Conservation Plan* (DNR 1998); *Forest Practices Habitat Conservation Plan Final Environmental Impact Statement* (DNR 2006); *Final Environmental Impact Statement of the Policy for Sustainable Forests* (DNR 2006).

Incremental impacts—socioeconomic effects on private, state, and federal forestlands

An important question being considered in this DEIS is whether the incremental effects of additional restrictions under any of the alternatives considered in this DEIS would contribute to existing socioeconomic trends in declining timber harvest, resulting in significant adverse effects to local communities.

As described in Chapter 3, Affected Environment, DNR state trust lands have undergone major shifts in policy and associated changes in on-the-ground management. Major policy changes include the following:

- 1997 *State Trust Lands Habitat Conservation Plan*
- 2006 *Policy for Sustainable Forest*
- 2006 Riparian Forest Restoration Strategy

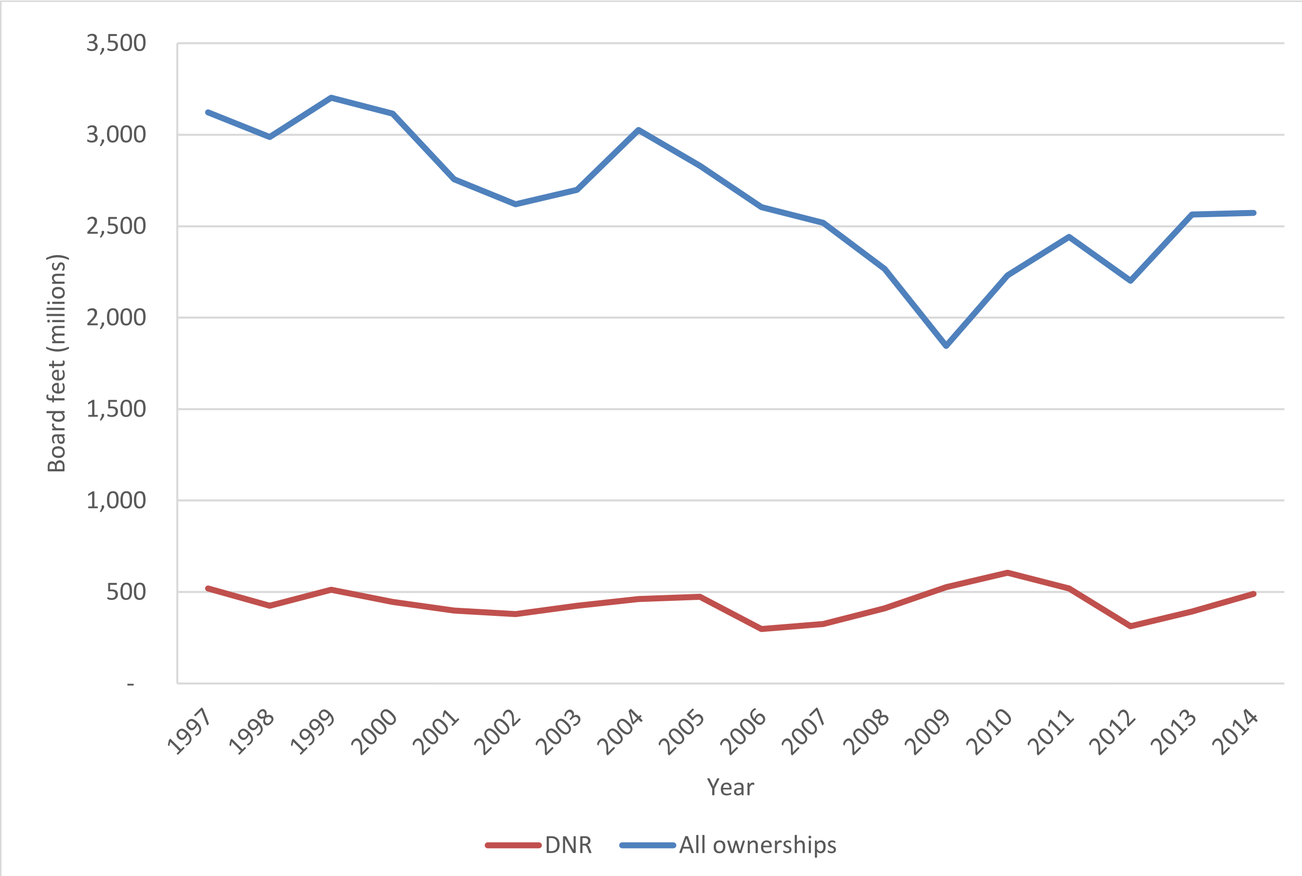
From 1997 to 2014, harvest volumes from state trust lands have fluctuated from 298 to 605 million board feet per year on land in counties in the analysis area. In the same period, harvest on all ownerships in counties in the analysis area have declined slightly since 1997 though harvests were lowest during the economic downturn in 2009 (Figure 5.1.2). At the county level, harvest volumes from DNR-managed lands have been relatively consistent in all counties. Total harvest volume has generally decreased since 1997 in Grays Harbor, Mason, Pierce, and Skagit counties and has increased in Jefferson County. The harvest level in other counties has been relatively stable.

Based on the 1997 through 2014 *Washington Timber Harvest Report*, DNR-managed lands for counties located in analysis area produced 17 percent of the total volume harvested in that period. The harvest volume ranged from 11 percent in 2006 to 29 percent in 2009 of the total volume. Harvest from private lands accounted for 81 percent of the total harvest volume from 1997 to 2014 and ranged from 87 percent in 2006 to 67 percent in 2009. Federal lands and other public lands produced between 1 and 4 percent of the total harvest volume.

Due to the abundance of private forestlands within the analysis areas, private forestlands are expected to continue to provide the majority of timber products to industry into the future, regardless of actions on state trust lands.

Considered collectively, socioeconomic trends have contributed to a cumulative reduction of timber harvest, which has led to associated adverse socioeconomic effects on local communities. It is uncertain whether the effects of the proposed alternatives, when added to existing trends, would be significant.

Figure 5.1.2. Timber Harvest Levels in the Analysis Area



INCREMENTAL REDUCTIONS IN AVAILABLE TIMBER

Alternatives C, D, E, and F would reduce timber harvest within lands designated as LTFC. The highest reduction in timber harvest is expected under Alternative F. Pacific and Wahkiakum counties may be significantly impacted (refer to Section 4.11) by reductions in available timber volume under Alternatives C, D, E, or F.

The cumulative economic effects related to regional forest policy decisions, regulatory strategies, and complex economic and social conditions have and will continue to occur at much larger scales than the effects that would occur due to amending the existing HCP for state trust lands. Even though up to 114,000 acres of additional LTFC may sound like a large amount of land, the incremental effect of this change may not be significant within the context of more than 12 million acres of commercial forestlands in western Washington (Daniels 2004), with the exception of impacts to Pacific and Wahkiakum counties as noted in Section 4.11.

Summary of incremental impacts

Table 5.1.1 summarizes past, present, and future forest management and land use activities within the analysis area and whether the alternatives incrementally add to those impacts.

Table 5.1.1. Incremental Impacts of Alternatives: Impacts Added to Past Effects and Future Trends Within the Range of the Marbled Murrelet in Washington

	Past	Present	Future actions and trends	Incremental additions of the alternatives
Marbled murrelets	Habitat loss, predation, and threats in the marine environment contributed to population decline. Nesting habitat has been reduced to about 12 percent of the historic habitat-capable area in Washington.	Population decline continues in Washington (current rate is estimated at 4.4%). Habitat losses on federal and state-managed land have been substantially reduced, while habitat loss on private forestlands continues. Conservation reserves on federal lands provide the primary role for marbled murrelet conservation and recovery, but habitat on state-managed lands is essential for the conservation of murrelets in landscapes that have limited federal ownership (e.g., southwest Washington).	Conservation of the marbled murrelet will be difficult to achieve if trends in habitat loss continue at the current rate. Habitat on private forestlands will continue to decline and will eventually be limited to known occupied marbled murrelet sites, riparian zones, and other deferrals under Washington forest practices rules. Nesting habitat in conservation reserves on federal lands is expected to increase over the next 50 years as young forests transition to more mature forests and the quality of existing habitat increases through a reduction of past habitat fragmentation and edge effects. Depending on the alternative, habitat losses balanced with habitat gains on DNR lands are projected to result in a net increase from the current level of about 15.5% habitat area to 23% to 27% habitat area over the next 50 years. If amount and configuration of nesting habitat is the primary factor driving murrelet population trends, murrelet populations are likely to increase as habitat area and quality gradually increase over time on both federal and state lands. However, cumulative	All alternatives are projected to result in increased nesting habitat area on DNR lands over the next 50 years. The increase in nesting habitat has the potential to slow or reverse the population decline by conserving habitat in long-term forest cover and mitigating the short-term impacts of habitat loss through the growth of new habitat, softening edge effects over time and imposing conservation measures that reduce disturbance and non-harvest impacts. Alternative B has the greatest potential to result in negative cumulative effects due to greater harvest of existing nesting habitat and lack of buffers on occupied sites. Alternatives C, D, E, and F all have potential to provide positive cumulative effects by conserving more existing habitat and recruiting additional habitat in key landscapes that are essential for conservation and recovery of marbled murrelets. Forestland conversions are expected to continue which can remove habitat or reduce effectiveness of existing habitat.

			ongoing impacts from other stressors in the marine and terrestrial environments that are outside the scope or control of the proposed action may also be contributing to ongoing population declines.	Climate change is expected to affect marine and terrestrial habitats.
Forest management	Historic timber harvest, clearing for agriculture and development, and reforestation over the past 100 years have created densely stocked stands with reduced timber productivity and wildlife habitat values. Wildlife habitat has been significantly reduced due to the loss and fragmentation of structurally complex forest stands.	Ongoing timber harvest has the potential for local adverse effects on soils, water, wildlife habitat, and other elements of the environment. Significant effects are typically avoided or mitigated through the existing policy and regulatory framework. Active thinning improves timber production and wildlife habitat values. Much thinning is conducted as part of commercial harvest.	Ongoing use of thinning will continue to increase timber productivity and wildlife habitat values.	Only Alternative B results in more land available for harvest compared with no action alternative. Other action alternatives include some local increases in land available for harvest but overall increase the amount of LTFC. The existing regulatory framework is sufficient to address the incremental effects of harvest. Thinning would decrease under some alternatives within some marbled murrelet conservation areas. Thinning may increase where needed to meet habitat objectives. Thinning may also increase due to certainty provided by long-term strategy (clarity around what land is truly "off-base" for future harvest).

	Past	Present	Future actions and trends	Incremental additions of the alternatives
Non-forestland uses	Road building, mineral extraction, and clearing for other types of infrastructure and development occurred. Developed facilities, recreational trails, and off-road vehicles can disturb soils, water quality, and riparian and wildlife habitats and attractant predators.	Policies and statewide regulations limit road density and protect soils, streams, and fish habitats. Recreation and non-timber land uses occur throughout public and private forestland. Current demand for communication facilities is high. Interest in energy developments is currently low. High levels of recreational use near urban areas, particularly in the South Puget planning unit.	Road densities are expected to remain constant. Future demands for mineral or energy leases on state trust lands may increase based on future market conditions. Effects would be addressed in project-specific planning efforts. Increasing recreation demands on forestland are expected as populations increase.	No additive effects are expected from the alternatives. Conservation measures limit new development in marbled murrelet habitat. Shifting demands for recreational uses can be addressed through forestland plans and project-specific planning. Potential local road reductions are expected within LTFC, which could impact access for other users. Overall, no net change to road density is expected.
Socio-economic effects (associated with timber volume)	From 1997 to 2014, harvest volumes have fluctuated on land in counties in the analysis area. Harvest on all ownerships in counties in the analysis area have declined slightly on all ownerships but remained more consistent on DNR-managed lands.	DNR-managed forestland produces an average of 17% of total harvest volume for counties in the analysis area. Private forestland produces approximately 81%, and federal lands and other public lands produce an average of 2%.	Private forestlands are expected to continue to provide the majority of timber products to industry into the future, regardless of actions on state trust lands.	Pacific and Wahkiakum counties may be significantly impacted by reductions in available timber volume under Alternatives C, D, E, or F (refer to Section 4.11).

Chapter 6

LITERATURE CITED

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Chapter 6

Literature Cited

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Chapter 7

KEY DEFINITIONS

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Chapter 7

Key Definitions

Active management: Intervening in the development of a forest stand through planting, thinning, managing competing vegetation, harvesting, or other stand management activities. Also referred to as "active forest management."

Bare land value: Bare land value (BLV) assesses the present net worth of an infinite number of successive, identical timber harvest rotations.

Biodiversity: The full range of life in all its forms as defined by the Washington Biodiversity Council.

Board foot: The amount of wood contained in an unfinished board 1 inch thick, 12 inches long, and 12 inches wide (2.54 x 30.5 x 30.5 centimeters), abbreviated bd. ft.; commonly, 1,000 bd. ft. is written as 1 MBF and 1,000,000 bd. ft. as 1 MMBF.

Board of Natural Resources (BNR or Board): As defined and authorized in RCW 43.30.215, the BNR consists of six members: the governor or governor designee; the Superintendent of Public Instruction; the Commissioner of Public Lands; the director of the School of Environmental and Forest Sciences at the University of Washington; the Dean of the College of Agriculture, Human, and Natural Resource Sciences at Washington State University; and a representative of those counties containing state forestlands acquired by the department. The BNR's duties include establishing department policy and setting appraisal value of lands and valuable materials including timber values offered for sale. See RCW 43.30.215 for more duties of BNR.

Buffer: A forested strip left during timber harvest to conserve sensitive ecosystems or wildlife habitat. Active management may be allowed as long as they are consistent with the conservation objectives for the buffer.

Commercial thinning: A thinning that generates revenue and is performed to meet a wide range of objectives, including improving the growth of the stand, enhancing stand health, reducing tree mortality, or accelerating the development of habitat.

Consultation: As used in this DEIS, "consultation" does not mean an ESA Section 7 consultation, but refers to the DNR informally contacting USFWS about a specific project to determine consistency with the HCP and the incidental take permit. DNR and USFWS may identify measures to avoid, minimize, and mitigate potential impacts to remain consistent with the HCP and incidental take permit.

Critical habitat (federal): Defined under the federal Endangered Species Act of 1973 for threatened and endangered species as "(i) the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 1533 of this title, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 1533 of this title, upon a determination by the [U.S.] Secretary [of Interior] that such areas are essential for the conservation of the species."

Cumulative impact: The incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can occur from individually minor but collectively significant actions taking place over time and space.

Deferral: As used in this DEIS, the term "deferral" or "deferred lands" refers to forestland that will not be harvested during the planning period due to a long-term conservation commitment under the 1997 HCP, *Policy for Sustainable Forests*, or other DNR conservation objectives.

Dispersal habitat: Habitat used by juvenile northern spotted owls or by this species at any age to disperse or move from one area designated for nesting-roosting-foraging habitat to another.

Endangered species: Any species of plant or animal defined through the Endangered Species Act of 1973 as being in danger of extinction throughout all or a significant portion of its range and published in the Federal Register.

Forest health: Defined in RCW 76.06.020 as "the condition of a forest being sound in ecological function, sustainable, resilient, and resistant to insects, diseases, fire, and other disturbance, and having the capacity to meet landowner objectives." RCW 76.06.140 points to "overcrowded" conditions (i.e., overstocking) as causing forest health impediment and to well-managed forests as the first line of defense.

Gene pool reserve: A stand that has been deferred from harvest to conserve native genetic material well-adapted to local conditions for the future.

Guy line: A cable stay used to hold up a logging tower, spar, or a tailhold tree.

Habitat conservation plan (HCP): A plan authorized under Section 10 of the federal Endangered Species Act that permits incidental take (in the course of an otherwise lawful activity) of a species protected under the Act.

HCP planning unit: An geographic area that is based on watersheds for the purpose of tying the minimization and mitigation more closely to the natural systems and geographic variation in habitat, to gain economies of scale, and to provide greater efficiency in planning and implementing the HCP.

High-quality spotted owl habitat: The most structurally complex habitat used by territorial northern spotted owls for nesting, roosting, and foraging. See *DNR State Trust Lands Habitat Conservation Plan 2015 Annual Report* for a more complete definition.

High-quality P-stage: Habitat with a P-stage score of 0.47 or above.

Landing: A widened area (often on or adjacent to a forest road) to which logs are yarded or skidded for loading onto trucks to be hauled to market.

Large data overlay: A complex GIS model comprised of hundreds of individual data sources describing DNR-managed lands. Examples of such data include forest inventory information, riparian and hydrology data, roads and trails, and other biological and physical information.

Long-term forest cover (LTFC): DNR-managed forestlands with commitments to maintain permanent forest cover provide long-term conservation benefits to the marbled murrelet. Areas of long-term forest cover have existing conservation commitments under the 1997 HCP, *Policy for Sustainable Forests*, Natural Heritage Program, forest practices rules, the OESF Forest Land Plan, and/or are identified as marbled murrelet conservation areas.

Low-quality P-stage: Habitat with a P-stage score of 0.25 or 0.36.

Management area for spotted owls: Lands identified and designated in the 1997 HCP to be managed for specific types of habitat for the northern spotted owl.

Marbled murrelet conservation area (MMMA): A generic term for a discrete area designated for marbled murrelet habitat conservation under one or more of the alternatives analyzed in this DEIS. Refers to: occupied sites and buffers, habitat identified under the interim strategy, emphasis areas, special habitat areas, marbled murrelet management areas, or isolated stands of higher-quality P-stage habitat.

National Environmental Policy Act (NEPA) of 1969: An act passed by the U.S. Congress to (1) declare a national policy which will encourage productive and enjoyable harmony between man and his environment; (2) promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; (3) enrich the understanding of the ecological systems and natural resources important to the Nation; and (4) establish a Council on Environmental Quality. In the state of Washington, NEPA's counterpart is the State Environmental Policy Act (SEPA).

Natural area preserve (NAP): Under authority of the state Natural Area Preserves Act of 1972 (codified in Chapter 79.70 RCW), an area established on public lands to protect the best remaining examples of many ecological communities, including rare plant and animal habitat. NAPs are managed by DNR under the Natural Areas Program.

Natural regeneration: Reforestation by natural seed-fall from existing stands and trees.

Natural Resources Conservation Area (NRCA): As codified in 1987 in Chapter 79.71 RCW, an area designated to protect outstanding examples of native ecosystems; habitat for endangered, threatened, and sensitive plants and animals; and scenic areas. The NRCA program represents a protection alternative to complement NAPs. NRCAs are managed by DNR under the Natural Heritage Program.

Nesting, roosting, and foraging (NRF) management area: A discrete area to be managed for sub-mature or better norther spotted owl habitat and nest patches.

Nest patch: Designated 500-acre patches that include a 300-acre patch for nesting and a 200-acre buffer of sub-mature or better habitat.

Old-forest habitat or old forest: As used in this DEIS, this habitat defines northern spotted owl habitat in the OESF planning unit (1997 HCP, p. IV.88).

Old growth (western Washington): DNR's *Policy for Sustainable Forests* defers old-growth stands from harvest, defined as stands, 5 acres or larger, in the most structurally complex stage of stand development, also referred to as fully functional (determined through a standard scoring method based on a scientist panel consensus). Old growth stands also refer to stands with a natural origin date prior to 1850, generally considered the start of European settlement in the Pacific Northwest.

Olympic Experimental State Forest (OESF): An HCP planning unit, about 264,000 acres of forested state trust lands on the western Olympic Peninsula, in which foresters and scientists seek to intentionally learn how to integrate revenue production and ecological values in a working forest.

Peak flow: Periods of high stream flow usually associated with storm events.

***Policy for Sustainable Forests*:** A policy document that provides broad direction for DNR, in the form of 23 policies, to effectively manage forested state trust lands. The *Policy for Sustainable Forests* was adopted by the Board of Natural Resources on July 11, 2006. The purpose of the *Policy for Sustainable Forests* is to conserve and enhance the natural systems and resources of forested trust lands managed by DNR to produce long-term, sustainable income and environmental and other benefits for the people of Washington.

Pre-commercial thinning: Thinning wherein felled trees have little or no market value (usually because of insufficient size) and are therefore are left where felled.

P-stage: A habitat classification system used in the development of the marbled murrelet long-term conservation strategy. Assigns a numeric value to forest stands based on the probability of their use by marbled murrelets for nesting.

Procedure: An explicit department direction for implementing policies such as those contained in the *Policy for Sustainable Forests*.

Reforestation: The reestablishment of forest cover either naturally (by natural seeding, coppice, or root suckers) or artificially (by direct seeding or planting). *Synonym:* regeneration.

Regeneration: The act of renewing tree cover by establishing young trees naturally or artificially.

Riparian management zone (RMZ): A protected band of vegetation adjacent to wetlands (called wetland management zone or WMZ), lakes, rivers, and streams that varies in width based on stream or wetland size and presumed ecological significance. The 1997 HCP designated RMZs and WMZs in order to protect salmonid and other aquatic and riparian obligate species.

Road maintenance and abandonment plan (RMAP): A plan that covers all forest roads on a landowner's property constructed or used for forest practices after 1974. It is based on a complete inventory that also shows streams and wetlands adjacent to or crossed by roads. The plan lays out a strategy for maintaining existing roads to meet state standards and shows areas of planned or potential road abandonment.

Salvage: Logging performed to sell blowdown, insect-infested, or otherwise damaged timber before natural processes cause deterioration in quality and value. Salvage harvest volume is not counted toward the sustainable harvest level set by the Board.

Security forest: A closed-canopy forest stand over 80-feet tall that is located adjacent to marbled murrelet nesting habitat and provides security from windthrow, predation, and other disturbances.

SEPA: The State Environmental Policy Act codified under Chapter 43.21C RCW.

Silviculture: The art and science of cultivating forests to achieve objectives. (This concept incorporates theory, planning, and practice at the stand through landscape/management area scales.)

Site preparation: Preparation of a final-harvested or intermediate-harvested forest management unit to increase the probability of successful regeneration by reducing slash and/or undesirable tree and brush species. Site preparation may be performed concurrent with logging (by, for example, pulling up and disposing of brush clumps), through piling and burning logging slash, through broadcast- or under-burning logging slash, by manually cutting undesirable vegetation, by applying herbicide (aerial or ground) to undesirable tree and brush species prior to planting, or other methods or combinations of methods. Compare to “vegetation management.”

Stand density: A quantitative measure of stocking expressed either absolutely in terms of number of trees, basal area, or volume per unit area or relative to some standard condition; a measure of the degree of crowding of trees within stocked areas commonly expressed by various growing space ratios (e.g., height/spacing).

Stand development stages: The generally recognized stages of forest stand development that would occur as trees and other organisms populate a piece of ground, grow into a stand, evolve in form, and gradually die in the absence of stand-replacement disturbance.

Stochastic: Referring to patterns resulting from random effects.

Stringer habitat: Stringer habitat is predominantly narrow riparian management zones (less than 200 meters wide) where adjacent uplands have not been designated as LTFC. This habitat is not part of the calculation of impact or mitigation.

Structurally complex stand: A forest stand in the in the niche diversification or fully functional stand development stages.

Sub-mature habitat: A northern spotted owl habitat definition for stands with the structural characteristics necessary to provide roosting and foraging functions and, rarely, nesting functions.

Sustainable harvest calculation: A strategic analysis process that quantifies forestry goals, such as future forest conditions and trust revenue, against forecasted near- and long-term effects of alternative sets of policy. This process is also used to recommend to the Board of Natural Resources the next decade’s sustainable timber harvest level. DNR is required by law (RCW 79.10.320) to periodically calculate and adjust the harvest level from forested state trust lands managed by DNR.

Tailhold: A stump, tree, rock bolt, or other immovable object to which a skyline is tied off or tail block attached.

Timber sale: A sale of timber from DNR-managed forested state trust land that is separate from the land.

Upland: Land above the ordinary high watermark of bodies of water. In everyday usage, the term refers to all lands above riparian management zones and aquatic lands, forested as well as not.

Variable-density thinning: A type of commercial thinning in which a mixture of small openings (gaps), un-thinned patches (skips), and varying stand densities are created to achieve specific objectives, such as accelerating development of a complex stand structure.

Variable retention harvest: A type of regeneration or stand-replacement harvest in which elements of the existing stand, such as down wood, snags, and leave trees (trees that are not harvested), are left for incorporation into the new stand. Variable retention harvest is different from a clearcut, in which all of the existing stand is removed.

Vegetation management: Weeding of undesirable competing vegetation, generally performed between planting and establishment, which may be performed through a variety of means such as hand-slashing or felling, mechanical means, herbicide applied from the ground, and herbicide applied by aircraft. Compare to “site preparation.”

Windthrow: Blowing over or breaking of trees in the wind.

Yarding: The act of moving timber to a landing using a cable system.

Appendix A: Scoping Report

Purpose of Scoping Report

This scoping report has been prepared between the Washington Department of Natural Resources (DNR) and the Fish and Wildlife Service in expectation of an Environmental Impact Statement under the National Environmental Policy Act and the State Environmental Policy Act for amending the 1997 *State Trust Lands Habitat Conservation Plan* (1997 HCP) for the implementation of the long-term conservation strategy (LTCS) for the marbled murrelet.

This report documents many of the steps taken to develop a Draft Environmental Impact Statement (DEIS) for the LTCS. It describes the scoping process from 2006 to date.

Background

The Washington State Department of Natural Resources (DNR) manages approximately 1.3 million acres of forested state trust lands within the range of the marbled murrelet. To provide certainty that DNR's management of these lands, pursuant to its fiduciary obligations, complies with the Endangered Species Act (ESA), DNR adopted a Habitat Conservation Plan (1997 HCP) that was approved by U.S. Fish and Wildlife Service (USFWS) in 1997. The 1997 HCP, a seventy-year agreement, covers a number of federally listed species, including spotted owls, salmonids, marbled murrelets, and other species of concern.

At the time of adoption, the 1997 HCP included an interim conservation strategy for the marbled murrelet. This interim strategy was to remain in place until more scientific information could be collected on habitat on state lands and the marbled murrelet's biological needs to make the development of a long-term conservation strategy (LTCS) possible. Since the signing of the 1997 HCP, DNR and other agencies, including the Washington State Department of Fish and Wildlife, have been collecting such information on all state trust lands within the range of the marbled murrelet.

In 2006, DNR began the process of formulating a LTCS. At that time, two HCP geographic planning units were not included: North Puget Sound and South Puget Sound. This difference, in addition to the difference in need and purpose statements, distinguishes the 2006 scoping process from those that followed in 2012 and 2013 (outlined in the following sections). Since the comments during the 2006 scoping period related to DNR's LTCS, they have been included here for consideration during the Environmental Impact Statement (EIS) process.

Since the proposal involves a single species within the exclusive jurisdiction of the USFWS under ESA, in January 2012, DNR and USFWS agreed to serve as co-lead agencies for the purposes of preparing an environmental impact statement on a proposal to amend the 1997 HCP to include a LTCS for the marbled murrelet in all HCP planning units within the range of the murrelet. The joint development of an EIS is intended to eliminate duplication by the two agencies and avoid delay, while recognizing each agency's independent responsibilities under SEPA and NEPA. As such, DNR is serving as the lead agency for the State of Washington in preparing the EIS to comply with SEPA and USFWS is serving as the lead federal agency in preparing the EIS to comply with NEPA. This scoping report describes the scoping activities conducted for this proposal.

Scoping Process

The start of the formal NEPA and SEPA public scoping period initiates the public involvement aspect of the EIS process. Analysis of comments received during public scoping contributes to determining the scope, focus, and content of an EIS. Scoping helps the lead agency to identify a range of actions, alternatives, environmental effects, methods of assessment, and mitigation measures to be analyzed in depth. It also helps to eliminate issues outside the scope of the EIS. The public scoping period provides an opportunity for active participation from a variety of audiences, including proponents and opponents of a proposed action, and it encourages expression of thoughts and/or concerns during the decision-making process.

DNR and USFWS have conducted scoping in two separate time periods for the LTCS: once in 2006 and then from 2012 to the present. In 2006, the agencies held four meetings and collected public comments to scope a proposal for the LTCS which included DNR lands in the OESF, Straits, South Coast, and Columbia HCP Planning Units (referring to the boundaries delineated in the 1997 HCP). In 2012, the Joint Lead Agencies expanded the proposal geographically to include the North and South Puget Planning Units, thereby incorporating all DNR lands within the range of the marbled murrelet into the proposal. They also adjusted the need and purpose statement and added five objectives.

During the second scoping process beginning in 2012, the Joint Lead Agencies chose to utilize an expanded scoping approach consisting of two phases, each of which included respective public meetings and comments. In the first phase, agencies requested comment on a statement of the proposal's need, purpose, and objectives (NPO) to guide the creation of the LTCS consistent with the commitments in the 1997 HCP. After consideration of public comments submitted during this phase, the Board of Natural Resources and the USFWS approved a final version of the need, purpose, and objectives statement for the proposal to be used in the draft environmental impact statement.

During Phase 2 of the same scoping effort, which occurred in 2013, the public commented on a proposal that described a set of alternative concepts, including a no action concept. The concepts included three distinct conservation approaches to a LTCS, each of which sought to be consistent with the need, purpose, and objectives approved during the first phase of scoping by the Board of Natural Resources and the USFWS.

■ Notice of Intent and Public Scoping Notice

On September 15, 2006, USFWS issued a federal Notice of Intent (Federal Register Vol. 71, No. 179) to conduct scoping as joint lead agency allowing for the development of a joint environmental impact statement. Also on September 15, 2006, DNR issued a Determination of Significance and Public Scoping Notice for the proposal to develop a LTCS, indicating that an EIS would be prepared. After the scoping notices were issued, public meetings were conducted and public comments were received. The Joint Lead Agencies have retained all comments received during each phase of the scoping process.

On April 20, 2012, USFWS issued a federal Notice of Intent to conduct scoping (Federal Register Vol. 77, No. 77), and DNR issued a Notice of Public Meetings and Request for Comments on the Scope of an Environmental Impact Statement Under the State Environmental Policy Act. This notice requested public comments related to a proposed statement of need, purpose, and objectives for the LTCS.

On May 13, 2013, DNR issued a Notice of Public Meetings and Request for Comments on the Scope of an Environmental Impact Statement Under the State Environmental Policy Act, requesting public comment related to a set of conceptual alternatives for the LTCS.

As a result of these notices and subsequent public meetings, the following public comments to date have been received:

1. 2006 Written Scoping Comments and Public Meeting Notes
2. 2012 Board Meeting Public Comments on Need, Purpose, and Objectives (March 2012, before scoping began)
3. 2012 Written Scoping Comments (formal comment period running April 20–May 21, 2012)
4. 2013 Written Scoping Comments (formal comment period running May 13–July 1, 2013)

■ Public outreach

During the 2006 scoping process, the Joint Lead Agencies requested information regarding several topics:

- Direct, indirect, and cumulative impacts that implementation of the proposed amendment or other alternatives could have on murrelets and other endangered and threatened species and their habitats
- Other possible alternatives that meet the purpose and need
- Information on murrelet ecology in southwest Washington and the Olympic Peninsula
- Potential adaptive management and/or monitoring provisions
- Funding issues
- Existing environmental conditions in the plan area
- Other plans or projects that might be relevant to this proposed project
- Minimization and mitigation efforts
- Baseline environmental conditions

DNR also requested comments on murrelet ecology in the central and north Cascades for their consideration, which could assist in developing the LTCS in those areas.

For Phase 1 scoping in 2012, the Joint Lead Agencies requested comments on the following topics in addition to any other key issues or broad topics identified by commenters:

- Environmental issues that should be addressed based upon the proposal's NPO

- Issues to consider in developing alternatives that achieve the NPO
- Specific mitigation measures the Joint Lead Agencies should consider to address identified issues or impacts;
- Impacts to elements of the natural and built environment resulting from the proposal that the Joint Lead Agencies should evaluate
- Identification of additional environmental information, studies, or reports relevant to the development of the proposal

For Phase 2 scoping in 2013, the agencies requested comments on the same topics as those requested during Phase 1 in 2012 (see preceding list). In addition to any other key issues or broad topics identified by commenters, there was one additional issue on which the Joint Lead Agencies requested comments:

- Any additional conceptual alternatives meeting the NPO that the Joint Lead Agencies should consider

■ Public meeting notice and news release

In order to inform interested members of the public of scoping meetings held during each scoping period, the Joint Lead Agencies issued several notices and news releases.

In 2006, both the NEPA Notice of Intent and the SEPA Scoping Notice identified the dates, times, and locations at which four public scoping meetings would be held. Legal notice of these meetings was made in The Olympian, Seattle Times, Bellingham Herald, The Daily News (Longview), and the Peninsula Daily News (Port Angeles) newspapers on September 17, 2006. Public notice of these meetings also was made through issuance of a press release by on September 13, 2006. Two reminder press releases were then released on September 20 and 26, 2006. In addition, public notice of these meetings was made through emails and mailings of paper notices by the DNR to all those on the Forest Practices Division "Meeting Agenda" and "SEPA Notices" mailing lists maintained by the DNR, which include affected tribes, municipalities, state agencies, organizations, and parties who have expressed interest in previous actions by DNR on forested state trust lands.

In 2012, joint public meeting notices were prepared and released by DNR and USFWS on April 13 and 19, 2012, and May 16, 2012. These releases also contained information about the scoping comment period and the LTCS process. Notice of the public meetings was also posted on the DNR website and published in the statewide SEPA Register. A Notice of Intent regarding the meetings and the DEIS process was published in the Federal Register on April 20, 2012.

In 2013, DNR and USFWS prepared a news release for publication on May 16, 2013, which announced the Phase 2 public scoping meetings. The news release was distributed to local news agencies. Notice of the public scoping meetings was also posted on the DNR website. In addition to these outreach efforts, an interested party letter was generated and sent both electronically and via USPS to tribes identified as stakeholders. Copies of the news release and interested party letter are provided on DNR's web site at the address listed at the end of this document.

■ Website

In 2006, DNR provided details regarding public scoping on the agency's web page, www.dnr.wa.gov.

For the 2012 scoping process, the DNR website provided scoping process and public meeting information on both a LTCS page and a separate project page on the DNR SEPA Center website. The websites provided links to the scoping notice and other background documents, as well as details about the comment period and public meetings.

In 2013, as in 2012, the DNR website provided scoping process and public meeting information on both a LTCS page and a separate project page on the DNR SEPA Center website. The links to additional background information and scoping meeting details were also included.

■ Public scoping meetings

The Joint Lead Agencies hosted public scoping meetings at various locations around the state to inform the public about the LTCS process and to solicit comments related to each stage of the scoping process (i.e. 2006, Phase 1 in 2012, and Phase 2 in 2013).

In 2006, DNR and USFWS held four meetings at the following times and locations:

1. September 26, 6:30 p.m. Forks—Olympic Natural Resources Center
2. September 28, 6:30 p.m. Mt. Vernon—Best Western CottonTree Inn
3. October 4, 6:30 p.m. South Bend—Willapa Harbor Community Center
4. October 5, 6:30 p.m. Lacey—Lacey Community Center

In addition to the oral comments received at the public scoping meetings, ten scoping comment letters were received along with some written comments handed in at the meetings. The ten letters consisted of 30 pages of original input. The comments submitted in these letters have been summarized in the Issue Summary section.

In 2012, DNR and USFWS staff conducted four public meetings at the following locations:

1. April 30, 6:00 p.m. Olympia—Natural Resources Building
2. May 3, 6:00 p.m. Sedro-Woolley—Northwest Region Office
3. May 8, 6:00 p.m. Cathlamet—Pacific Cascade/River Room
4. May 9, 6:00 p.m. Forks—Olympic Region Office

The Joint Lead Agencies solicited public comments as a part of Phase 1 of the scoping process related to the NPO. DNR received about 2,040 comment letters, with about 2,000 of them coming from Sierra Club members and containing similar content. DNR staff reviewed all comments and identified those that contained comments requesting specific changes to the NPO. Those comments are summarized in the Issue Summary section.

As part of Phase 2 of the scoping process related to the Conceptual Alternatives for the LTCS, the Joint Lead Agencies conducted four public meetings at the following locations:

1. June 5, 5:00 p.m. Olympia—Natural Resources Building
2. June 10, 5:00 p.m. Sedro-Woolley—DNR Northwest Region Office
3. June 12, 5:00 p.m. Forks—DNR Olympic Region Office
4. June 19, 6:00 p.m. South Bend—Pacific County Courthouse Annex

The Joint Lead Agencies received 1,976 comment letters, with 1,905 of them coming from Sierra Club members and containing similar content. Most of the comments were sent by email, with a small amount being sent via USPS. There were 29 stakeholder groups that commented, including local and state agencies, tribes, and environmental and industry groups. There were 37 individuals who commented who were unaffiliated with any specific stakeholder group. The staff of the Joint Lead Agencies reviewed all comments and identified those that contained comments specifically regarding the three proposed Conceptual Alternatives. Those comments, along with all other comments, are summarized in the next section.

Issue Summary

Issues identified during the scoping processes are separated below into the three different stages of scoping: 2006, Phase 1 in 2012, and Phase 2 in 2013. Regardless of when the comments were submitted, all comments were considered prior to drafting the DEIS.

Public comments received during the 2006 scoping process were summarized separately from the Phase 1 scoping in 2012 and the Phase 2 scoping in 2013. The primary reason for this separation was that the 2006 process covered a different geographic scope and a different need and purpose statement. (See previous section, Scoping Process, for additional details.)

■ Public Comment Summary 2006

This section includes specific comments made during the scoping process in 2006. The comments below are broken into general comment categories.

Habitat Conservation Plan/Conservation Strategy proposal development

Commenters suggested that the LTCS should address the following issues:

- Compensating for timber harvesting on late-successional federal lands managed under the Northwest Forest Plan.
- Maintaining a global (landscape) perspective to consider activities on other ownerships.
- Developing a strategy that is not too broad and allows for site specific management.
- Meeting public interest in making the plan successful and fulfilling the objectives discussed in the factsheet provided at the public meetings.
- Developing a conservation strategy that ensures, through routine quantitative measurements, that

marbled murrelet populations are stable or increasing, well-distributed, and resilient to natural disturbances and climate change.

- Developing a plan that is extensive, strong, and robust and does as much as possible for marbled murrelet recovery.
- Determining the LTCS to be either more or less restrictive than the interim strategy with regard to marbled murrelet populations.
- Protecting all known occupied marbled murrelet sites.
- Balancing the needs of marbled murrelets with those of other species.
- Coordinating/integrating with other HCP strategies, such as the riparian strategy, in the process of creating this strategy.
- Incorporating OESF as an unzoned forest as specified in the HCP.
- Implementing the unzoned forest approach for ten years, then re-evaluating
- Describing how the strategies for the South Puget and North Puget planning units will be incorporated into the current HCP proposal.
- Considering alternatives that delay harvest in unsurveyed higher quality habitats until strategies for acquiring functional nesting habitat have been confirmed.
- Disallowing timber harvesting in unsurveyed areas (such as in the OESF) until field surveys can be completed.
- Analyzing options for reclassified (higher quality) habitat areas other than harvest.
- Using innovative silvicultural options and define alternatives that are most likely to create desired suitable habitat in the shortest amount of time.
- Evaluating alternatives using multiple silvicultural pathways.
- Considering research done by the Olympic Natural Resources Center, University of Washington, and the U.S. Forest Service Pacific Northwest Research Station during the scoping process.
- Including an adaptive management plan for alternatives evaluated describing the outcome for any affected habitat areas should they be released for harvesting.

Additionally, a commenter suggested that DNR postpone work on the LTCS until the Science Team Report has been completed and distributed and all field surveys and habitat inventories in the South and North Puget planning units have been completed.
In addition, commenters noted that the long-term conservation strategy should contain the following components:

- Measurable outcomes
- Language on buffers
- Definitions of innovative silvicultural techniques that are quantitative, repeatable, and scientifically sound
- A standardized mitigation plan
- A monitoring/adaptive management plan with measurable objectives for recovery, provisions for plan reviews, research to test assumptions and the effectiveness of management actions, and corrective actions as needed
- Estimated amount of released habitat acres and a timeline for release

Environmental Impact Statement contents

SEPA/NEPA— GENERAL PROCESS

A commenter suggested that there are several points to consider regarding the SEPA/NEPA process, specific to this project:

- Explain how this process integrates with that of the OESF planning process
- Include tribal involvement
- Ensure compliance with the Information Quality Act
- Describe the status of the trust lands and DNR's fiduciary responsibilities in the NEPA/SEPA document.

IMPACTS

Commenters suggested that the EIS address the following issues related to the potential impacts of the LTCS:

- Impacts to other habitats, species, and ecological factors
- Impacts to recreation and other public interests
- Impacts to marbled murrelets from release of habitat
- Impacts from the interim strategy compared to projected impacts from the long-term strategy
- Impacts on revenue to trust beneficiaries
- Effects on income/job loss and revenue on the OESF, particularly on low-income and minority populations
- Impacts of DNR's action on other land owners, particularly those adjacent to DNR-managed lands
- Effects of innovative silvicultural techniques on revenue at a planning unit level and by trust
- Whether removing timber harvest lands from the market is jeopardizing the future of the industry
- Whether the revised strategy violates the Growth Management Act
- The effects of random catastrophic events and global climate change
- The cumulative impacts from other projects such as wind power development on state lands on the long term conservation strategy.
- Effects on timber volume and value in deferred and released areas at the planning unit level for the OESF.

Need for additional information

"More information about marbled murrelets is requested, in order to comment on an appropriate, scientifically credible LTCS. Explain the habitat needs of the marbled murrelet and whether they have additional needs from those of the northern spotted owl."

MARBLED MURRELET HABITAT—GENERAL

- Habitat protection should focus on areas with known high marine marbled murrelet population densities.
- Habitat protection should be focused on the landscape level with abundant, well-distributed habitats, as well as protection of unoccupied suitable habitat.
- If protection on federal lands is weakened, DNR will need to compensate for this change by providing additional marbled murrelet habitat protection.

HABITAT MODELS

- DNR should analyze conservation options using all current marbled murrelet habitat and identify priority landscapes for conservation.
- If the silvicultural models sometimes misclassify young forest stands with marginal conditions as old forest, DNR should not rely on this information to predict where conservation is appropriate.
- DNR needs to evaluate the accuracy of modeled habitat categories (and include validation techniques used, individual stand data used, and confidence intervals) for the proposed LTCS recommendations.

HABITAT RESTORATION

- Having a conservation plan will streamline species and habitat management and improve habitat development and restoration.
- Protection and restoration efforts should address both current and future marbled murrelet habitat, but those habitat restoration efforts should not be used as mitigation for destruction of existing marbled murrelet habitat.
- DNR should provide an analysis of riparian zones as marbled murrelet nesting habitat and the amount of interior forest and the wind firmness of those riparian corridors.

MARBLED MURRELET SURVEY EFFORTS

- DNR should continue survey efforts to locate additional marbled murrelet habitat and allow those lands to be deferred from timber harvest.
- DNR should survey other important areas besides those for nesting.
- Models used to predict occupancy are unreliable and cannot replace field surveys to determine occupancy.
- If the survey effort was insufficient, it is possible that protection measures will be insufficient.
- The EIS should provide a comparison of marbled murrelet survey methodologies for designating occupied stands or determining habitat use and a discussion of the adequacy of the survey effort.

State Trust Lands

FIDUCIARY RESPONSIBILITY

- DNR should maintain or increase current sustainable harvest levels in affected counties and advocate for the trust beneficiaries while protecting the marbled murrelet. Fiduciary responsibility and ESA compliance should be equitably distributed over the state spatially and temporally.

ROLE OF TRUST LANDS

- Consider all the roles of trust lands, including conservation, revenue, and low-impact recreation and the importance of the role of forested state trust lands for conservation, not recreation, in the future.

TIMBER HARVEST

- DNR should consider forest management on state trust lands that emphasizes diversifying stands.

TRUST REVENUE

- DNR should estimate acreage of deferred lands and associated impacts to trust revenue. Many counties lack alternate federal lands for protecting marbled murrelet habitat where mitigation areas might be located.

■ Public Comment Summary—Phase 1

This section includes specific comments made during the Phase 1 scoping process in 2012. The comments mentioned below are broken into the main comment categories, which were related to the main topic of the Phase 1 process, the need, purpose, and objectives of the LTCS.

Need, purpose, and objectives

OPPOSE THE NPO AS WRITTEN

"The appropriate Purpose and Need for the LTCS should be to contribute to the recovery of the Marbled Murrelet, as well as to comply with the requirements of the federal Endangered Species Act ('ESA') and the terms of DNR's ITP and HCP. Instead, the current language of the proposed joint NPO Statement unreasonably narrows the scope of alternatives that will be evaluated in the EIS by couching the Purpose and Need of the proposal in terms of DNR's financial interests."

"The NPO Statement should focus on DNR's need to comply with its incidental take permit ('ITP') and HCP by designing and implementing long-term conservation measures for the Marbled Murrelet on state trust land for the purpose of 'help[ing to] meet the recovery objectives of the [USFWS], contribut[ing] to the conservation efforts of the President's Northwest Forest Plan, and mak[ing] a significant contribution to maintaining and protecting marbled murrelet populations in western Washington over the life of the HCP' (DNR 1997 at IV.44)."

"Furthermore, the USFWS should not adopt these statements as its own. Instead, as declared in the original EIS for the HCP, the USFWS's statement of Need should reflect its responsibilities under federal law: '(1) to conserve listed species [and] their habitats…; and (2) to ensure compliance with the ESA, National Environmental Policy Act (NEPA), and other applicable federal laws and regulations,' and not WDNR's beneficences to its fiduciaries (WDNR 1998). The USFWS's stated Purpose should also be simply to 'determine whether the WDNR HCP, as amended by the LTCS for the Marbled Murrelet, satisfies the ESA Section 10 permit issuance criteria and other applicable laws and/or regulations.' 77 Fed. Reg. 23,743, 23,744 (Apr. 20, 2012)."

SUGGESTED CHANGES TO NPO

"The need statement should be revised to read:

> "Need: To fulfill DNR's obligation under the 1997 Trust Lands HCP to adopt a Marbled Murrelet Long Term Conservation Strategy."

We believe this more accurately describes why the agencies are undertaking the project. Long-term certainty for timber harvest and other management activities may or may not be best achieved by continuing to operate under the terms of the HCP.

The statement of Need that we suggest clearly and concisely states the reason that DNR is undertaking this project without opening these issues up for further interpretation."

This comment was contained in several comment letters from timber industry stakeholders: "We support the Purpose, Need and Objectives statement endorsed by the Board of Natural Resources. However, we think that it should be made clearer that each alternative must meet all five of the Objectives. Please add the phrase 'which achieves all the following objectives' at the end of the Purpose statement."

Other commenters made similar suggestions, such as:

- "Proposed revision to purpose statement: To develop a long-term habitat conservation strategy for marbled murrelets on forested state trust lands in the six west-side planning units that will minimize and mitigate for any incidental take of this species, subject to the DNR's fiduciary responsibility to the trust beneficiaries as defined by law and USFWS' responsibilities under the ESA, which achieves all of the following objectives.'"
- "Some clarification should be made as to whether each objective should be equally weighted, in addition, to whether all five objectives must be met. The presumption is that they should, but the document could be clearer in providing direction to that effect."

Upon completion of the scoping phase, DNR and USFWS revised the NPO.

Related to Specific Objectives

OBJECTIVE #1: TRUST MANDATE

"The agencies need to maintain clarity about what the state's responsibility is under the State Trust Lands Habitat Conservation Plan (HCP). The HCP requires 'minimization and mitigation for any incidental take' (HCP, Part IV, page 39). While the long term conservation strategy is likely to improve conditions for the marbled murrelet over time thereby contributing to the species recovery, the state's responsibility is not to provide for recovery of the species. If the state and trust beneficiaries are required to manage for a standard higher than this, it is within the state's authority to terminate the HCP and manage these lands utilizing a 'take' avoidance strategy.

The agencies should emphasize Objective #1 (Trust Mandate) and Objective #3 (Active Management) as a reasonable alternative. Within this context, the agencies should consider impacts to counties highlighted in Daniels 2004."

"The HCP has already surrendered a substantial portion of the long-term productivity of the state's trust land for species protection by modifying silvicultural treatments, extending rotation ages and providing set asides. These mitigations and protection measures will result in development of old-forest conditions over time in riparian areas, on steep and unstable slopes, and on other areas protected under the HCP. These protections will continue to benefit the marbled murrelet. The long-term conservation strategy must result in no decrease in the long-term and short-term harvests from the trust lands covered by the HCP."

"Clarification should be made as to what 'making trust property productive' means. For example, under that objective, increasing the net present value could be argued to be 'productive,' but would result in the beneficiaries clambering for revenue if timber stands were left to simply mature thereby increasing their net present value. As there is no specific statement that addresses providing revenue to the beneficiaries, such a statement is either needed or clarification is required regarding the phrase noted above."

"DNR should articulate on a trust by trust basis the economic impact the MM strategy will have on the trust revenue."

OBJECTIVE #2: MARBLED MURRELET HABITAT

"Only one of five Objectives even mentions Marbled Murrelets (Objective 2). To ensure that viable alternatives for the LTCS are evaluated during the joint NEPA/SEPA process, the identified Objectives of the LTCS should 'direct a strategy that will be useful in protecting and maintaining habitat, decreasing the risk of loss of suitable habitat, maintaining or increasing the reproductive success of the Marbled Murrelet, and increasing adult survivorship' (DNR at IV.43).

To that end, the proposed Objectives for the LTCS should reference achievement of biological goals that will contribute to Marbled Murrelet recovery. Biological goals adopted in DNR's report entitled *Recommendations and Supporting Analysis of Conservation Opportunities for the Marbled Murrelet Long-Term Conservation Strategy* ('2008 Science Report') were developed to help meet the USFWS's recovery objectives, and also provide relevant language for the stated Objectives of the LTCS: 'WDNR [should] manage forest habitat to contribute to the following three biological goals: a stable or increasing population, an increasing geographic distribution, and thus a population that is resilient to disturbances' (USFWS 2011, Raphael and others 2008)."

"Clarification is needed as to why the Department would be required to exceed its obligations within the HCP in expecting the Department 'to make a significant contribution to maintaining and protecting marbled murrelet populations.' The inclusion of the word 'significant' could imply that the Department would be required to provide a greater share or contribution to the marbled murrelet beyond its legal requirements under the Endangered Species Act and within the HCP."

"Proposed Revision:

> '<u>Provide for</u> Marbled Murrelet Habitat ... In accomplishing this objective, <u>DNR</u> expects to make a significant contribution to maintaining and protecting Marbled Murrelet populations:
>
> > a) by utilizing the Northwest Forest Plan – the first 15 years (1994-2008) – Status and Trend of Nesting Habitat for the Marbled Murrelet (2011) and other pertinent research documents for guidance purposes;
> > b) by implementing the recommendations contained in the Marbled Murrelet Science Team Report (Recommendations and Supporting Analysis of Conservation Opportunities for the Marbled Murrelet Long-Term Conservation Strategy) (2008) as appropriate; and
> > c) by utilizing other relevant scientific resources and science-based practices as they may become available in the future.'

By adding the above wording, the valuable body of scientific knowledge pertaining to Marbled Murrelet ecology would be properly referenced in the MMLTCS scoping document."

"In general, the Proposal is acceptable except I am concerned the words 'significant contribution' in Objective #2 could obligate the State to requirements impossible to achieve and harm the Trusts financially. To date, not enough is known about the needs and impacts on the Murrelet in this State to make additional commitments. Presently there are considerable portions of State Lands set aside for species protections and there is no guarantee that adding more protections than what already exist will help the Murrelet."

■ Public Comment Summary—Phase 2

During the Phase 2 scoping process, various stakeholders preferred different conceptual alternatives; for example, environmental stakeholders for the most part preferred Conceptual Alternative #1 over the other conceptual alternatives because it included the protection of all occupied sites.

The Joint Lead Agencies were particularly interested in the five topics listed above in the *Public Outreach* section. Comment examples related to these topics are provided below in addition to comments related to other topics that commenters felt were important.

Comment examples:

There were some comments that addressed the issues included in the Phase 2 scoping notice; these comments are listed below. Commenters also had a wide range of opinions on the conceptual alternatives, as described in the Issues section that follows.

- Follow the recommendations in the 2008 Science Report; it is the best science available. (from Sierra Club and other conservation advocates)
- Protect all occupied sites with significant buffers. (from Sierra Club and other conservation advocates)
- Lands set aside for other conservation purposes, such as Natural Area Preserves, Natural Resources Conservation Areas, unstable slopes, etc., should be first areas reviewed/considered for marbled murrelet habitat conservation. (from American Forest Resource Council and other industry advocates)
- Buffers around marbled murrelet conservation areas should be managed areas, not no-touch set-asides. (from American Forest Resource Council and other industry advocates)
- Analysis of the LTCS impact should be on a county-by-county basis. (from American Forest Resource Council and other industry advocates)
- All relevant research and economic data on the impact of conservation set-asides on the state economy should be considered, along with the impact on revenue to each of the constitutional trust beneficiaries and each timber county. (from American Forest Resource Council and other industry advocates)

In addition to receiving comments on the topics described in the scoping notice, the lead agencies also received comments on these topics:

- Interim strategy
- Management activities
- Need, purpose, and objectives
- Reasonable range of alternatives
- Trust responsibility
- Miscellaneous

Issues

Commenters noted their preferences on these conceptual alternatives, as well as on other topics (described below in the Comment examples: Topics not included in Phase 2 scoping notice section).

RELATED TO NO ACTION ALTERNATIVE

There were strong opinions on this alternative from conservationists:

- "Abandoning the HCP would call into question many of DNR's own commitments and policy goals," including those protecting other species such as the northern spotted owl.

- CRANE commented that for the DNR "to shirk its responsibilities to the marbled murrelet suggests that it could do the same for all of its other commitments in the HCP."
- Washington Forest Law Center (WFLC) commented that the "structure of the HCP and the analysis approving the HCP demonstrate that all of the species' protections are intertwined and that removing the murrelet conservation program risks sacrificing the entire HCP."

RELATED TO CONCEPTUAL ALTERNATIVE #1

Many commenters agreed with this conceptual alternative's approach, that all occupied sites must be protected; these commenters pointed out that the variable buffer width approach, as described in the public scoping meetings, would be possible with reliable data.

The concern about reliable data was related to marbled murrelet predators, according to CRANE: "There is still much uncertainty about the interrelation between edge effects, fragmentation, and corvid behavior, and about the corresponding MM population responses. Although avoiding fragmentation is almost assuredly helpful, there have been no long-term studies to determine if, how quickly, and to what extent predator populations will continue to expand from edge areas into the forested interior."

Some commenters thought that this alternative was most closely aligned with the Trust Objective, but only if the alternative was "refined to define high quality habitat and to ensure compliance with fiduciary responsibilities."

RELATED TO CONCEPTUAL ALTERNATIVE #2

Many commenters, primarily those aligned with conservation groups, did not prefer this conceptual alternative. They explained that all occupied sites must be protected, not just most or all, and in all HCP planning units. Commenters agreed with the idea of conservation areas, as included in this conceptual alternative and in Conceptual Alternative #3, to protect murrelet habitat and decrease the edge effect.

Industry commenters disagreed with the inclusion of the OESF HCP planning unit in this conceptual alternative; they commented that DNR should not introduce special management areas for the murrelet in OESF. Another basis for industry commenters' disagreement was their belief that the use of conservation areas to decrease edge is misguided, as the marbled murrelet is an "edge species and does not use the interior of the stands."

RELATED TO CONCEPTUAL ALTERNATIVE #3

Regarding Conceptual Alternative #3, both conservation and industry commenters repeated their concerns about Conceptual Alternative #2. For example, commenters associated with conservation groups repeated concerns that all occupied sites must be protected and in all HCP planning units.

Industry commenters noted that this conceptual alternative was the next best alternative after Conceptual Alternative #1 since it "allows OESF to continue to operate as an unzoned forest." Industry commenters also repeated their concerns about decreasing edge, which in their view, is detrimental for the marbled murrelet. Lastly, industry commenters noted that while serving as set-asides, conservation areas will reduce beneficiary revenues to hard-hit counties in southwest Washington.

Comment examples: Topics not included in Phase 2 scoping notice

For the additional comment categories listed above in the Comment examples: Popular Comments section, examples of comments in each of these categories are included here.

Interim Strategy
Some commenters felt that while the interim strategy is in effect and the LTCS is being developed, DNR should be applying the precautionary principle to avoid harming murrelet recovery. Further, commenters expressed concern that DNR's current measures are insufficient for marbled murrelet recovery. Others saw the interim strategy as the starting point for a LTCS.

Management Activities
If the LTCS results in a decreased volume target from that of the interim, some commenters advocated for a commensurate decrease in other HCP protections. Others expressed concern that there may be a surplus in habitat protected on state lands that should be released for management. Similarly, some of these commenters advocated that there should be no further reduction beyond the interim strategy in timber available for harvest from state-managed trust lands.

Other commenters supported the active management of stands to develop old-growth characteristics that would provide beneficial habitat for murrelets.

Need, Purpose and Objectives
Some commenters support the BNR's and USFWS' intent to ensure alternatives meet all of the objectives under the NPO. They further expressed interest in alternatives that provide for commercially viable harvests.

Other commenters expressed skepticism that the Science Team Report meets Objective #1, since, in their view, the Science Team Report was completed without consideration for DNR's fiduciary responsibility to the trusts.

Reasonable Range of Alternatives
Some felt a reasonable range would have to extend between more protective measures for marbled murrelets and less protective measures. They also felt measures should include protections that exceed those in the interim strategy. Others found little distinction between Conceptual Alternatives #2 and #3.

Other commenters recommended that the range of alternatives in the DEIS incorporate past, present, and foreseeable future events that have had both positive and negative impacts on the threatened species.

Trust

Many commenters reminded the Joint Lead Agencies that all trusts must be treated equally under the LTCS. Some commenters proposed incentives to include within the proposal, such as:

- Allowing DNR logs to be exported
- Continuing logging of non-habitat areas
- Exchanging lands to compensate trust beneficiaries (i.e. encumbered lands legislation)

Miscellaneous

Many commenters advocated for protecting resources such as old-growth trees because of other benefits such as providing clean air and water, sustaining a healthy climate, and supporting other wildlife species.

If the Joint Lead Agencies pursue protection of state lands due to federal regulations, a commenter felt that the federal government must provide compensation for that loss of productive commercial forest. Others would like to see a plan that provides for the recovery of the marbled murrelet.

■ Comments sent to USFWS

A considerable number of comments have been received by USFWS throughout the scoping process. The comments were diverse, but there were general patterns. Specific key areas of concern were expressed around certain impacts to the human and natural environments.

In 2014, the Sierra Club Northwest Office facilitated the mailing of a comment card to the USFWS Lacey Office that stated, in part, for the Fish and Wildlife Service to persuade the DNR to adopt an aggressive conservation strategy that will recover marbled murrelets. To date (October 2015), the USFWS has received 411 of these all similar comment cards.

Subsequent to the formal scoping process, in 2015 USFWS (and DNR) received a comment letter from the Washington Forest Law Center describing recent science around the marbled murrelet population decline and highlighting the role state lands play in recovery, noting the particular importance of the Straits and the need for habitat cohesion and restoration.

■ Public Comment Received at Board of Natural Resources Meetings (2015)

Staff from USFWS and DNR presented draft alternatives to the Board of Natural Resources on October 15, 2015. The drafts, as well as maps and supporting materials, were posted on the DNR website ahead of the meeting. Public comment received at the meeting highlighted the following points:

- Long-term forest cover should include functional habitat for the marbled murrelet
- Concern over county revenue sources and potential impacts from marbled murrelet mitigation

- DNR has a fiduciary responsibility to the trusts; long-term strategy will have implications for state trust lands, including financial impacts to schools and counties
- Proposed look at other factors driving the change in marbled murrelet population
- Support for Alternative E (note: this is now Alternative F)
- Buffers on nesting sites should be larger
- Concern that habitat is allowed to grow and mature on state lands
- Need to share more information about the details of the alternatives
- Suggestion to combine Alternatives C and D

A second Board meeting was held November 3, 2015 to discuss the draft alternatives. The goal of this meeting was to get agreement from the Board to pursue a draft EIS covering the five alternatives presented. Public comment received at that meeting highlighted the following points:

- Importance of the trust mandate, including funding of local services such as the Timberland Regional Library
- Don't exclude alternatives not meeting the purpose and need statement; support for Alternative F
- Support for combining Alternatives C and D; Consider establishing a 150-meter buffer in a combined C and D alternative
- Suggestion to test more protective alternatives
- Concern that a large number of acres conserved would reduce sustainable harvest and impact school trusts
- Preserve the intent of OESF.

The BNR also received over 700 emails with identical text from individuals in Washington and around the country urging development of a long-term strategy and calling for marbled murrelet conservation and recovery.

■ Additional information

Marbled murrelet project DNR web page: www.dnr.wa.gov/marbledmurrelet

Scoping notices and meeting materials can be found on DNR's website here: www.dnr.wa.gov/mmltcs

Washington Department of Natural Resources (DNR). 1997. Final Habitat Conservation

Plan (State Trust Lands). Olympia, Washington. September. Available electronically at:

www.dnr.wa.gov/ResearchScience/Topics/TrustLandsHCP/Pages/lm_hcp_trust_lands_report.aspx

Appendix B. Analytical Framework Focus Paper

The Analytical Framework

Focus Paper #1

This focus paper was part of a series presented to the Board of Natural Resources in October and November 2015 to inform development of the marbled murrelet long-term conservation strategy alternatives. The purpose of this paper is to describe the framework of assumptions agreed to by DNR and USFWS to guide the development and evaluation of the marbled murrelet long-term conservation strategy.

What is the analytical framework?

The analytical framework is a methodology agreed upon by DNR and the U.S. Fish and Wildlife Service (USFWS), also referred to as the “Joint Agencies,” to provide objective, repeatable, science-based estimates of potential impacts and mitigation to marbled murrelet habitat from DNR’s land management activities under the Habitat Conservation Plan (HCP). The analytical framework provides the means to assess how DNR’s mitigation measures cover potential impacts. This quantification will enable the Joint Agencies to evaluate whether a proposed conservation strategy meets the issuance criteria for the Incidental Take Permit.

The analytical framework is based on a principal hypothesis of murrelet conservation biology: the quantity and quality of nesting habitat affects the murrelet population.[1] The interaction of habitat quantity and quality determines the overall number of nesting opportunities, and proximity to forest edges[2] reduces nest success (USFWS 1997). This framework is based in current murrelet science, and makes use of detailed landscape data applicable to DNR lands. The analytical framework provides a means to derive objective answers to questions that the Joint Agencies began asking when discussing the specifics of forming a long-term conservation strategy for the murrelet. These questions included:

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[1] See “Report on Marbled Murrelet Recovery Implementation Team Meeting and Stakeholder Workshop” April 2012. USFWS.

[2] A “forest edge” is an abrupt transition between two populations of trees, where the characteristics of the forest on one side are different from the other.

- How is habitat distinguished from non-habitat?
- How does stand structure and composition affect habitat quality?
- How do forest edges created by timber harvest and forest roads influence habitat quality?
- How does habitat quality influence its value to murrelets?
- How can impacts to habitat be quantified?
- How much habitat conservation meets the requirements of an HCP?

The analytical framework also includes an approach to evaluating impacts on the population of marbled murrelets under different conservation alternatives (a "biological implications" analysis). Figure 1 illustrates the key pieces of the framework.

Figure 1. Key Pieces of the Analytical Framework

What is the analysis area for the analytical framework?

The analysis area for the analytical framework is all DNR-managed lands within 55-miles of all marine waters in western Washington. This 55-mile line is the same as was used in Northwest Forest Plan (USDA, 1994), and is used by USFWS as an estimate of the inland range of the marbled murrelet in Washington.

The total land covered by the analysis area is approximately 16 million acres. DNR manages 9% of this land, or just over 1.3 million acres. DNR organizes its habitat conservation based on ecological units called "HCP Planning Units", including Olympic Experimental State Forest (OESF), Straits, South Coast, Columbia, North and South Puget. (See Figure 2.) Other lands within the analysis area are owned and managed by private industries, municipalities, organizations and individuals, as well as federal agencies. Table 1, below, includes a breakdown of ownership within the analysis area.

Figure 2. Analysis Area for the Analytical Framework

Not all of the lands owned and managed by DNR within the analysis area are marbled murrelet habitat. A key component of the analytical framework is defining what constitutes marbled murrelet habitat on DNR's lands so that conservation strategies, impacts, and mitigation can be evaluated.

Table 1. Land Ownership within Analysis Area

Land within 55 miles of saltwater	Acres	
Total land regardless of ownership	16,056,074	
	Acres	Percent
US Forest Service, USFWS, National Park Service land	4,165,681	26%
DNR land	1,377,933	9%
Private and Other	10,512,460	65%

How is habitat defined in the analytical framework?

In order to quantify potential mitigation and impacts, the Joint Agencies need to determine where habitat exists today and into the future on DNR's lands within the analysis area. The approach to assessing potential marbled murrelet habitat was arrived at after constructing a probabilistic model to estimate nesting habitat using survey data and then developing an expert-driven classification of this probabilistic model to give it greater geographical applicability. This classification model, known as "P-stage," was created and peer-reviewed as part of the Science Team Report (Raphael and others 2008), and is refined for use in the long-term strategy. By using this model, the Joint Agencies can:

- Project habitat development into the future, allowing an estimate of how much habitat will grow during the remainder of the HCP;
- Identify habitat and classify its quality at the stand level;
- Use information compatible with DNR's forest inventory data;
- Apply the same habitat model across all DNR-managed lands in the analysis area.

Focus Paper #3, "Estimating the Location and Quality of Stands of Marbled Murrelet Habitat," details the P-stage methodology and how it compares to other habitat models.

What are areas of Long-Term Forest Cover?

The analysis area includes lands already protected by the multi-species HCP in place for DNR trust lands, or other state laws and policies that guide the management of forest lands. Areas of long-term forest cover (LTFC) include lands where DNR maintains and grows forest cover for conservation purposes, including habitat conservation for the marbled murrelet. These areas potentially provide marbled murrelet nesting habitat and support their conservation. The location, size, and quality of these areas will vary among the conservation alternatives being developed. Focus Paper #2, "Areas of Long-Term Forest Cover," gives a detailed description of what lands are included in LTFC.

How are potential impacts defined in the analytical framework?

Based on an assessment of activities that are permitted under DNR's Habitat Conservation Plan, the Joint Agencies identified three categories of potential impacts as **harvest impacts, edge-influenced impacts,** and **disturbance impacts**. These three types are briefly described below; for additional detail on how each type quantifies potential impacts, see Focus Paper #5, "Potential Impacts and Mitigation."

What are harvest impacts?

Harvest impacts result in the removal of potential marbled murrelet habitat (acres with P-stage value) through harvest activities. Harvest mostly occurs in areas outside of LTFC (some thinning may be allowed within LTFC for purposes of improving forested habitats over time). New road construction associated with harvest is another impact. The effects on the marbled murrelet from harvest impacts include possible loss of nesting habitat and loss of potential future reproduction.

What are edge-influenced impacts?

Edge-influenced impacts are associated with the forest edge left after harvest activities. Roads also create edges. Edge effects include microclimate changes, increased predation, and increased windthrow. Each of these effects can have a detrimental impact on marbled murrelet nest success.

What are disturbance impacts?

Disturbance impacts are effects on murrelets that may occur from actions that generate loud noises and activity in close proximity to nesting murrelets. These types of disturbances can result in a potential disruption of murrelet breeding and nesting behaviors.

The Joint Agencies identified 36 DNR activities that may cause disturbance. Examples are:

- Recreational site use
- Sand and gravel sales
- Electronic site maintenance
- Road use and maintenance
- Collection of western greens, Christmas greens, and mushrooms.

A step-by-step description of how disturbance impacts are evaluated is included in Focus Paper #5, "Potential Impacts and Mitigation."

How is mitigation defined in the analytical framework?

To quantify mitigation the Joint Agencies examine how many acres of long-term forest cover have a P-stage habitat value today and at the end of the HCP in 2067. Habitat values are adjusted based on time, edge effects, and other factors including geographic location. DNR's mitigation credit is calculated by subtracting current habitat from the future habitat in order to assign mitigation credit to total growth of habitat over the life of the HCP.

The alternatives that the Joint Agencies will build will feature different levels of conservation area acreage; this variation will accordingly alter the amount of mitigation credit and the potential impacts. A description of how mitigation credit is calculated is included in Focus Paper #5, "Potential Impacts and Mitigation."

How does the analytical framework relate to the development and analysis of conservation alternatives?

Development of the long-term conservation strategy includes an analysis of different alternatives for managing and protecting murrelets on DNR's trust lands. Five alternatives have been developed for analysis under a draft Environmental Impact Statement (DEIS). The alternatives represent a range of possible habitat conservation approaches for the murrelet.

The analytical framework provides the common playing field for analyzing and comparing these alternatives. For example, although management approaches and amounts of habitat set aside for conservation may differ among alternatives, the same methodology to evaluate their potential impacts will be applied across all alternatives.

Evaluating population impacts

DNR provided the habitat data used in the development of alternatives to Dr. Zach Peery of University of Wisconsin to evaluate the biological implications of different conservation approaches. He modeled relative impacts to the population (both regionally and on DNR lands) from each alternative. This information will be used as part of the environmental impact statement work evaluating the alternatives, and may be used by USFWS for their biological opinion on the conservation strategy.

Literature Cited

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Appendix C. Population Viability Analysis (Peery and Jones 2016)

Note: This report is currently undergoing peer review. This review is expected to be complete before the final EIS for the marbled murrelet long-term conservation strategy.

USING POPULATION VIABILITY ANALYSES TO ASSESS THE POTENTIAL EFFECTS OF WASHINGTON DNR FOREST MANAGEMENT ALTERNATIVES ON MARBLED MURRELETS

Submitted to:

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August 25, 2016

EXECUTIVE SUMMARY

The marbled murrelet (*Brachyramphus marmoratus*) was listed as threatened in Washington, Oregon, and California under the Endangered Species Act in 1992 due to commercial logging of nesting habitat, oil spills, and gill net entanglement. In 2012, the Washington Department of Natural Resources (DNR) initiated the development of a statewide, long-term conservation strategy for marbled murrelets to replace the 1997 Habitat Conservation Plan implemented after initial listing. We used population viability analysis (PVA) approaches to evaluate the potential future (50-year) effects of proposed management alternatives (A – F) on marbled murrelets in Washington. To do so, we developed a stochastic, two-population model linking murrelet demographic rates to forest conditions on DNR and non-DNR lands, and used this model to evaluate each proposed alternative's relative potential to both lead to *Risk* and *Enhance* murrelet populations. Proposed alternative F generally resulted in the greatest number of murrelets and lowest quasi-extinction probabilities, whereas alternative B always resulted in the lowest murrelet population size and highest quasi-extinction probabilities, in both the *Risk* and the *Enhancement* scenarios and at the two spatial scales considered (DNR lands versus state of Washington). Thus, alternative B posed the greatest risk to murrelet populations and alternative F provided the greatest capacity to enhance murrelet populations. At the state level, alternative F was projected to lead to 53 and 295 more murrelets than alternative B under the *Risk* and *Enhancement* scenarios, respectively. In addition, all alternatives except B were projected to lead to larger murrelet population sizes at year 50 than alternative A (the "no action" alternative), regardless of the spatial scale or scenario. The same pattern was generally observed for quasi-extinction probabilities, although differences between alternative A and the other alternatives were not quite as consistent as they were for projected mean population size. In a separate sensitivity analysis, we found that, acre-for-acre, murrelet population growth was most sensitive to changes in high-quality nesting habitat (Pstages 0.89 and 1), and while still sensitive, less so to changes in the raw acreage of nesting habitat or nesting habitat configuration (i.e., edge conditions). While we believe our model is sufficiently robust and well-parameterized to help assess how the proposed management alternatives may impact murrelet populations, our results must be considered in light of uncertainly about the effects of future changes in climate and stressors in the marine environment. Future efforts would benefit from using spatially-explicit models that provide (i) geographically-targeted (local) estimates of risk, (ii) prioritize stands for conservation and management, and (iii) generate more realistic insights into how changes in the spatial arrangement of nesting habitat may influence regional murrelet population viability. However, spatially-explicit population models are relatively complex in structure and would benefit from additional research designed to fill key information gaps in our understanding of murrelet ecology and environmental factors influencing murrelet populations.

Table of Contents

INTRODUCTION

The U.S. Endangered Species Act of 1973 (hereafter "ESA") prohibits the "take" of species listed as threatened or endangered (U.S. Congress 1973). In 1982 the ESA was amended to provide flexibility to non-federal land owners with endangered species on their property by granting an "incidental take permit" if they developed a Habitat Conservation Plan (HCP). Under Section 10 of the ESA, HCPs represent planning documents intended to ensure that anticipated take of a listed species will be minimized and mitigated to the maximum extent practicable by conserving the habitat upon which the species depend. Since issuance of an incidental take permit is a federal action, consultation under Section 7 of the ESA must also occur. Through the consultation process the U.S. Fish and Wildlife Service (FWS) determines if the proposed action is likely to lead to "jeopardy" which, according to the regulations implementing the ESA, is when an action "…reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). Although not a statutory requirement, another component of HCP development is addressing whether proposed management alternatives contribute to the recovery of the species as a whole, which is considered to be "an integral product of an HCP…" (US Fish and Wildlife Service 1996).

HCP negotiations and Section 7 consultations typically consider a wide range of information pertinent to the threatened or endangered species including, but not limited to, current habitat distribution and population trends as well as projections of future habitat and population status. Modeling approaches such as Population Viability Analyses (PVA) are frequently used as part of Section 7 consultations and HCP negotiations to evaluate the potential effects of proposed activities on threatened and endangered species (Harding *et al.* 2001; Morris *et al.* 2002). While the ability of PVA approaches to evaluate absolute levels of risk has been questioned, they remain well-suited to compare the relative effects of alternative management strategies on species of concern (Beissinger & Westphal 1998). However, addressing how well different management alternatives both lead to risk and support recovery raises conceptual and practical challenges, even when projections are limited to relative comparisons. Many, if not most, endangered species are declining in numbers and face extirpation due to the cumulative effects of multiple environmental stressors over broad geographic areas that extend beyond the effects of local habitat management within the HCP planning area. In these cases, understanding an alternative's capacity to support recovery may require additional, optimistic assumptions about, for example, improvements to other stressors that impact vital rates. Thus, simultaneously addressing these two questions—namely risk of extirpation/extinction and potential for recovery— as part of Section 7 consultations for endangered species, may require two distinct, yet parallel, modeling efforts. Further, modeling results must often be coupled with consideration of other factors such as geographic distribution for a complete jeopardy analysis.

The marbled murrelet (*Brachyramphus marmoratus*) is a small seabird endemic to the west coast of North America that generally nests in coastal old-growth forests and forages in marine nearshore environments (Meyer, Miller & Ralph 2002). The murrelet was listed as a federally threatened species in Washington, Oregon, and California under the ESA in 1992 primarily because of the loss of older, complex-structured forests to timber harvest, and edge effects from ongoing forest fragmentation (U.S. Fish and Wildlife Service 1997). However, a host of other factors unrelated to forest management likely impact murrelet populations including marine foraging conditions, disease, oil spills, and by-catch from gill net fishing (Peery *et al.* 2004; Raphael 2006). Nevertheless, the relative importance of each of these factors in driving recent population declines is not well understood (Raphael and Falxa *In Press*).

The Washington Department of Natural Resources (DNR) manages forests on "state trust lands" as fiduciary trusts to provide revenue to specific trust beneficiaries, such as schools, universities and other public institutions. In accordance with Section 10 of the ESA, the DNR developed a Habitat Conservation Plan in the late 1990's (Washington Department of Natural Resources 1997) which was an ecosystem-based forest management plan intended to help the DNR develop and protect habitat for at-risk species, including several federally threatened species (e.g., marbled murrelet and northern spotted owl *Strix occidentalis caurina*), while carrying out forest management and other activities on the state trust lands it manages. In 2012, the DNR formally began a process to amend the 1997 HCP to include a long-term conservation strategy for the marbled murrelet that incorporated a more recent body of scientific information on murrelet biology and habitat needs. The revision of the DNR's HCP seeks to simultaneously address the question of risk and contribution to recovery, a question complicated by the fact that by our analytical framework, habitat on DNR lands contains only about 15% of the carrying capacity for murrelets in Washington (and less in the tri-state area) and multiple, poorly understood environmental stressors likely impact murrelet populations regionally.

To provide insight as to whether forest management alternatives proposed as DNR's long-term conservation strategy may lead to risk or support significant contributions to recovery of murrelet populations in Washington, we used two parallel modeling frameworks—a "*Risk*" and an "*Enhancement*" analysis—that differed in assumptions about future impacts of environmental factors on murrelets beyond habitat change on DNR lands. In the *Risk* analysis, we assumed that current population declines were, in part, a function of recent loss of nesting habitat, and that the current population exceeded the nesting carrying capacity and was expected to decline further because of density-dependent effects. However, we also assumed that undetermined, chronic environmental stressors have contributed to population declines by reducing vital rates (reproduction and survival) such that the population was expected to continue to decline even after the population reached carrying capacity, albeit at a slower rate. While there is uncertainty in the environmental and anthropogenic factors responsible for recent population declines, parameterizing the model such that projected populations declined at approximately the same rate as recent estimates provided some biological realism to the model. This analysis was thus intended to provide a relative comparison of future state-level risk among management alternatives and to provide a general assessment of how risk can be modulated by forest management alternatives on DNR lands, particularly in light of recent population declines (Miller *et al.* 2012).

While the first analysis provides perspective on risk, estimating differences in risk among alternatives superimposed on expected future, substantial (ca. 5% annual) population declines does not necessarily provide a basis for assessing the extent to which the alternatives may support murrelet recovery. Put simply, we had an *a priori* expectation that potential increases in nesting habitat on DNR-managed lands are unlikely, by themselves, to provide a substantial contribution to the recovery of the considerably larger state-wide population experiencing significant declines likely owing to a host of factors in addition to the nesting habitat on state lands. From the perspective of evaluating a forest management plan, the question of recovery might be cast as: "if other stressors are ameliorated, how do the alternatives differ in their ability of DNR managed-lands to increase local breeding populations?" Therefore, in the *Enhancement* analysis, we developed an alternative parameterization of the model where we assumed that (i) the availability of nesting habitat was the primary cause of recent population declines and the most important factor limiting future population growth, and (ii) that other environmental stressors would not appreciably limit potential future recovery. Thus, as with the *Risk* analysis, murrelets were expected to decline initially at approximately the same rate as estimated with at-sea monitoring, but at some point in the future, the population would reach equilibrium with nesting carrying capacity and that the intrinsic population growth rates were sufficient for the population to increase in response to potential increases in nesting habitat. This second approach, then, provides a more direct means to "credit and debit" the DNR for expected increases and decreases in nesting habitat on their lands using population metrics, under the important assumption that other chronic stressors in the environment will not impede recovery.

We implemented this dual modeling approach using a stochastic meta-population model that provided a framework for projecting expected changes in the abundance of murrelets in the state of Washington under various forest management alternatives currently under consideration by DNR and FWS. The model links changes in murrelet population dynamics to expected changes in the quantity, quality, and configuration of nesting habitat on DNR lands over time (that varied among management alternatives) through ecological processes that were reasonably well-supported by the literature and that were agreed upon by DNR and FWS (Washington Department of Natural Resources 2016a). It included two subpopulations linked demographically by dispersal, where the subpopulations represented murrelets nesting on DNR and non-DNR lands. In our model, the dispersal process was spatially implicit; we did not explicitly consider the complex, landscape-scale distribution of murrelet nesting habitat on different landownerships in the state of Washington because many of these processes are not well understood and fully addressing these complexities was deemed beyond the scope of the Conservation Strategy negotiations by the involved resource agencies. The metapopulation model made a number of additional simplifying assumptions as the secretive behavior and marine habitats of marbled murrelets challenges field studies needed to parameterize the model described below. Thus, and as is the case with all PVA exercises, projections of risk should not be considered as absolute estimates, and only be interpreted in a relative manner (Beissinger & Westphal 1998). However, our objective was to develop a population model where differences in projected risk among management alternatives were sufficiently robust to violations of assumptions and uncertainty that the involved agencies could identify which alternative best met joint objectives. More broadly, we sought to understand how using parallel *Risk* and *Enhancement* analyses could facilitate management decisions and endangered species conservation while meeting legal obligations of the Endangered Species Act and DNR's policy goal of making a "significant contribution" to murrelet conservation. *In doing so, we recognize it is beyond our purview to provide recommendations as to whether individual alternatives impact murrelets such that "...survival and recovery in the wild is appreciably reduced" or whether they benefit murrelet populations to the point that they "contribute to the recovery of the species as a whole".* While we do highlight when, and under what circumstances, an individual alternative might increase/decrease risk or may increase the likelihood of recovery via population gains, we make no judgments as to whether modeled impacts on populations are sufficient to meet specific FWS regulatory criteria related to jeopardy or population recovery. While this distinction is subtle, we believe it is an important one.

METHODS

Model Structure and Parameterization

Matrix Model Structure. We developed a female-based, stochastic meta-population model that employed a one-year time step in accordance with the annual breeding cycle of marbled murrelets (Nelson 1997). Each of the two subpopulations (DNR and non-DNR lands) contained five stages classes: juveniles, 1-year old subadults, 2-year old subadults, adult (≥3-year olds) nonbreeders that did not breed because of insufficient nesting habitat, and adult breeders (≥3-year olds; Figure 1). The five stage classes were indexed $x = 1, 2, \ldots, 5$ in the order presented above, and DNR and non-DNR lands were indexed as $L = 1$ and 2, respectively. Note that, at times, the ≥1-year-old stage classes (non-juveniles) are collectively referred to as after-hatch-year (AHY) individuals for convenience. Model parameters are defined in Table 1, and the rationale for assumptions behind the selected model structure and parameter values are described throughout the next several sections.

The life-cycle diagram can be expressed mathematically as a matrix model that determines the number of individuals in each stage class at time $t + 1$ based on the number of individuals in each stage class in year t (Caswell 2001; Morris & Doak 2002). The murrelet meta-population model $\mathbf{A}_t$ consisted of four submatrices that defined local demographic and dispersal processes (Hunter & Caswell 2005):

$$\mathbf{A}_t = \begin{bmatrix} \mathbf{A}_{1,t} & \mathbf{M}_{2,t} \\ \mathbf{M}_{1,t} & \mathbf{A}_{2,t} \end{bmatrix}$$

The two submatrices on the main diagonal ($\mathbf{A}_{L,t}$) governed local demographic processes on DNR and non-DNR lands, denoted $\mathbf{A}_{1,t}$ and $\mathbf{A}_{2,t}$, respectively. The two submatrices in the off-diagonal determined murrelet dispersal between the two landownerships where the submatrix governing dispersal from DNR lands to non-DNR lands was $\mathbf{M_{1,t}}$ and the submatrix governing dispersal from non-DNR to DNR lands was $\mathbf{M_{2,t}}$ (the dispersal matrices are described in more detail below). The demography submatrices were structured as follows:

$$\mathbf{A_{L,t}} = \begin{bmatrix} 0 & 0 & s_{3,L,t}g_{3,L,t}bf_{L,t} & s_{4,L,t}g_{4,L,t}bf_{L,t} & s_{5,L,t}(1-g_{5,L,t})bf_{L,t} \\ s_{1,L,t} & 0 & 0 & 0 & 0 \\ 0 & s_{2,L,t} & 0 & 0 & 0 \\ 0 & 0 & s_{3,L,t}(1-g_{3,L,t})(1-d_{L,t}) & s_{4,L,t}(1-g_{4,L,t})(1-d_{L,t}) & s_{5,L,t}g_{5,L,t} \\ 0 & 0 & s_{3,L,t}g_{3,L,t}(1-d_{L,t}) & s_{4,L,t}g_{4,L,t}(1-d_{L,t}) & s_{5,L,t}(1-g_{5,L,t}) \end{bmatrix}$$

In these matrices, $s_{x,L,t}$ represented the annual survival rates, $g_{x,L,t}$ represented the probability of transitioning (transition rate) from stage class x (conditional on survival and population fidelity), $d_{L,t}$ was the annual dispersal rate, b was the breeding probability, and $f_{L,t}$ was nest success. Note that $g_{1,L,t}$ and $g_{2,L,t}$ were always equal to 1 and are therefore not presented in either the life cycle diagram or the matrix model.

Parameterizing Survival Rates ($s_{x,L,t}$). The model was parameterized with an annual survival rate of 0.87 and 0.90 in the *Risk* and *Enhancement* analyses, respectively, for after-hatch-year females ($s_{2,L,t}$ to $s_{5,L,t}$) based on a mark-recapture study of 331 individual marbled murrelets in central California (Peery *et al.* 2006) (Table 1). A pooled survival rate was used for these four stages classes because it was not possible to distinguish beyond juvenile versus after-hatch-year at the time of the mark-recapture study. We assumed the annual juvenile survival (s_1 and s_6) was 70% of after-hatch-year survival based on differences in survival rates between these stage classes in other alcid species (insufficient juveniles were captured to estimate juvenile survival directly; Peery et al., 2006a).

Parameterizing Breeding Probabilities (b,$f_{L,t}$*).* We treated the parameter *b* as the expected proportion of individuals in the breeding stages (i.e., that were "in possession" of a nest site) that actually nested in each year. We assumed that some fraction of breeders did not nest each year because, in seabirds, some individuals typically forgo nesting due to, for example, poor foraging conditions (Peery *et al.* 2004). The proportion of breeders has been estimated using radio-telemetry in the state of Washington, but estimates are likely biased low as a result of transmitter effects (Peery et al., 2006b, M. G. Raphael *pers. comm.*). A similar study in central California (Peery *et al.* 2004) used assays of plasma calcium (an indicator of eggshell deposition) and vitellogenin (an egg yolk precursor) to identify radio-marked individuals that did not nest but were physiologically in breeding condition at the beginning of the breeding season (indicating they likely would have nested in the absence of radio-tagging). Peery et al. (2004) found that 77% of sampled murrelets either initiated nesting or were physiologically in breeding condition. However, some individuals that were not detected nesting and were not in breeding condition may have nested and failed prior to radio-tagging. Thus, we used *b* = 0.90 as a reasonable estimate for the proportion of breeders in the state of Washington. Note that we assumed *b* was constant across years and equal 0.90 in both landownerships. However, we incorporated the effects of environmental variability on *b* implicitly by treating expected fecundity ($m_{L,t}$: the product of the proportion of breeders, *b,* and nest success, $f_{L,t}$, divided by two; see below) as a random beta-distributed variable in the population projection model as described above.

Modeling Transition Probabilities ($g_{x,L,t}$*).* Transition rates ($g_{x,L,t}$) provided the primary mechanism linking the demographic model to potential changes in the availability of nesting habitat resulting from forest management activities. Transition rates for the 2-year subadult and nonbreeding stages into the breeding stage class ($g_{3,L,t}$ and $g_{4,L,t}$, respectively) were calculated based on the number of individuals seeking nests sites relative to the number of available nests in year t + 1 in landownership L. For example, if the number of murrelets seeking nest sites (i.e., 2-year old subadults plus nonbreeders) was less than the number of available nest sites, then $g_{3,L,t}$ and $g_{4,L,t}$ = 1, such that all murrelets found nest sites. If the number of murrelets seeking nest sites exceeded the number of available nest sites, then $g_{3,L,t}$ and $g_{4,L,t}$ < 1 such that not all 2-year old subadults and nonbreeders in the population become breeders in year t + 1. Thus, if the number of nest sites in a given landownership ($K_{L,t}$) declined, for example as a result of timber harvesting, transition rates into the breeding class would also decline and fewer individuals would reproduce (effectively reducing the expected population growth rate). Conversely, if the number of nest sites increased (for example, as a result of forest growth and maturation), transition rates into the breeding class would tend to increase and more individuals would reproduce (effectively increasing the expected population growth rate). Mathematically, transition probabilities for landownership L in year t and were calculated as follows:

$$g_{3,L,t} = g_{4,L,t} = \frac{K_{L,t+1} - s_{5,L,t}n_{5,L,t}(1 - g_{5,L,t})}{s_{3,L,t}, n_{3,L,t} + s_{4,L,t}n_{4,L,t}}$$

The numerator in this equation represented the number of available nest sites (carrying capacity minus the number of surviving breeders from the previous year), whereas the denominator represented the number of potential new breeders seeking nest sites (surviving 2-year subadults and nonbreeders from year *t*).

Reductions in the number of nests sites ($K_{L,t}$) could also impact population growth by causing some breeders in possession of a nest site in year *t* to transition to the nonbreeder stage in year *t* + 1 ($g_{5,L,t}$):

$$g_{5,L,t} = 1 - \frac{K_{L,t+1}}{K_{L,t}}$$

For example, if half of existing nest sites were lost in year *t*, half of the surviving breeders in year *t* would transition to the nonbreeder stage in year *t* + 1. As described above, nonbreeders could transition back to the breeding stage if nests became available (e.g., through forest growth), but the model assumed that breeders that lost their nest sites as a result of habitat loss became nonbreeders for at least one year.

Parameterizing Dispersal Rates ($\mathrm{d}_{\mathrm{L,t}}$*) and Modeling Dispersal Processes.* Modeled murrelet populations in the two landownerships were linked demographically by the dispersal of individuals, where the annual dispersal rate from DNR to non-DNR lands, and from non-DNR to DNR lands, was defined as $d_{1,t}$ and $d_{2,t}$, respectively. The submatrix representing dispersal from land ownership *L* was structured as follows:

$$\mathbf{M}_{\boldsymbol{L,t}} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & s_{3,L,t}g_{3,L,t}d_{L,t} & s_{4,L,t}g_{4,L,t}d_{L,t} & 0 \end{bmatrix}$$

For example, if L = 1, then the matrix $\mathbf{M}_{\mathbf{1},\boldsymbol{t}}$ would represent dispersal from DNR to non-DNR lands in year *t*. The model assumed that dispersal movements were made by 2-year subadults and nonbreeders as these individuals transitioned to breeding stages in either landownership; juveniles and 1-year subadults remained in their natal population until they were old enough to breed. Individuals in breeding stages were assumed to remain in their respective populations such that “breeding dispersal” was effectively zero, a reasonable assumption based on anecdotal observations of the re-use of the same nesting site by murrelets in consecutive years (R. T. Golightly *pers. comm.*) as well as generally strong breeding fidelity in alcids (Gaston & Jones 1998). Dispersal rates between DNR and non-DNR lands are unknown, but approximately 85% of existing carrying capacity for murrelets in Washington occurs on non-DNR lands and 15% occurs on DNR lands. Thus, if we assume natal dispersal is random with respect to landownership, d_1 would be 0.85 and d_2 would be 0.15. However, a cap to the number of dispersers, and thus the dispersal rates was imposed by the number of available nest sites in the receiving population. Thus, if the number of dispersers calculated based on the dispersal rate exceeded the number of available nest sites in the receiving population, the “realized” dispersal rate was adjusted as follows for murrelets dispersing from DNR lands:

$$d_{1,t} = \frac{K_{2,t+1} - (s_{3,2,t}n_{3,2,t} + s_{4,2,t}g_{4,2,t}n_{4,2,t} + s_{5,2,t}[1 - g_{5,2,t}]n_{5,2,t})}{s_{3,1,t}(1 - g_{3,1,t})n_{3,1,t} + s_{4,1,t}(1 - g_{4,1,t})n_{4,1,t} + s_{5,1,t}g_{5,1,t}n_{5,1,t}}$$

Here, the numerator represents the number of available nest sites on non-DNR lands in year *t* + 1 after “local” recruitment by resident 2-year subadults and nonbreeders, whereas the denominator represents the number of available recruits from DNR lands in year t + 1. The analogous adjustment for dispersal rates from non-DNR lands was made as follows:

$$d_{2,t} = \frac{K_{1,t+1} - (s_{3,1,t}n_{3,1,t} + s_{4,1,t}g_{4,1,t}n_{4,1,t} + s_{5,1,t}[1 - g_{5,1,t}]n_{5,1,t})}{s_{3,2,t}(1 - g_{3,2,t})n_{3,2,t} + s_{4,2,t}(1 - g_{4,2,t})n_{4,2,t} + s_{5,2,t}g_{5,2,t}n_{5,2,t}}$$

As with local recruitment into the breeding stage, the model assumed that dispersing individuals selected nesting habitat in the destination population independent of habitat quality and edge conditions.

Initial Population Sizes ($\mathrm{n}_{\mathrm{x,L,0}}$*).* We set the population size in year t = 0 of model projections equal to one-half of the mean annual population size (our model was female-based and we assumed a 50% sex ratio) for the state of Washington estimated with at-sea monitoring from 2011 to 2015 (n = 3,616 individuals; Falxa et al., In Press). The total number individuals (i.e., females) was allocated to DNR and non-DNR lands in proportion to the distribution of nesting habitat that currently exists on each of the two landownerships (0.15 and 0.85, respectively), which yielded a total 542 individuals in the DNR subpopulation and 3,074 individuals in the non-DNR subpopulation. Within each subpopulation, we allocated individuals to the stage classes in accordance with the expected stable age distribution associated with a deterministic version of the matrix model structure that was parameterized as described above. Initially, nonbreeding and breeding stages ($n_{4,L,0}$ and $n_{5,L,0}$, respectively) were pooled (both classes treated as "adults") when determining the stage distribution in year t = 0. Adults were then allocated to the nonbreeding and breeding stages in year t = 0 as described below such that the number of adults exceeded the carrying capacity to a degree that provided reasonable correspondence between modeled population trajectories and observed trends in the Washington population.

Evaluating "*Risk*" and "*Enhancement*"

We parameterized the matrix model in both the *Risk* and *Enhancement* analyses using the values described above and listed in Table 1. We assumed that 40% of individuals of breeding age (≥3 years old) were in the nonbreeding stages in year $t = 0$ for each subpopulation and thus that the number of adult-aged individuals exceeded nesting carrying capacity for both analyses (see below). As described above, we made this assumption to reflect nesting habitat loss in the state of Washington that may have resulted in a nonbreeding component of the population. Moreover, associated density dependent effects on population growth allowed projected populations to decline in the initial years of the modeling period in reasonable accordance with recent observed declines (see below). The after-hatch-year annual survival rate was set to 0.87 and 0.90 in the *Risk* and *Enhancement* analyses, respectively. Higher survival rates in the *Enhancement* than *Risk* analysis allowed projected populations in this scenario to increase in response to potential gains in nesting habitat. For the portion of the *Enhancement* analysis focusing on DNR lands only, we assumed no dispersal between subpopulations to highlight "debits" and "credits" of forest management alternatives for losses and gains in nesting habitat, respectively, using population metrics.

Together, these assumptions yielded deterministic projections of population growth under constant habitat conditions that were reasonably consistent with the recent estimates of population trends (5% annual decline) in the initial years of the population projection. As the breeding-age component of modeled populations approached nesting carrying capacity, the rate of population growth increased in both the *Risk* and *Enhancement* analyses. The expected population growth rate stabilized around year 15 under the *Risk* analysis, but stabilized below 1 (a population growth rate of 1 is indicative of a stable population), and the simulated populations were thus expected, on average to decline (by approximately 1.5% annually) over the projection period. By contrast, population growth stabilized above 1 under the *Enhancement* analysis, and thus we expected small population increases (approximately 1% annually) over the modeling period.

Modeling the Impact of Nesting Habitat Change on Marbled Murrelet Populations

As described above, we modeled the potential effects of forest management alternatives on marbled murrelet population dynamics by linking the maximum number of breeders (carrying capacity, $K_{L,t}$) and nest success rates ($f_{L,t}$) to forest conditions (i.e., nesting habitat) present in the two landownerships in each year *t*. We assumed that availability of nesting habitat limits murrelet breeding opportunities and that forest fragmentation reduces nest success via edge effects. Specific measures of nesting habitat considered were nesting habitat (1) area, (2) quality, and (3) configurations (Washington Department of Natural Resources 2015). These three measures were initially quantified at the forest stand scale using DNR's spatially-explicit forest inventory database which contains information on mapped stands of known acreage such as characteristics of age, origin (natural vs. planted), and composition (Douglas-fir vs. shade-tolerant). Stand-level characteristics were ultimately aggregated to develop estimates of the maximum number of breeders and expected nest success in each landownership. The analytical methods, rationale, and assumptions used to derive estimates of carrying capacity and nest success are described below in conceptual terms. For a more detailed, mathematical explanation, we direct the reader to Appendix A.

Effects of Forest Conditions on Carrying Capacity ($K_{L,t}$*).* The model imposed a limit to the number of breeders ($K_{L,t}$) in each landownership based on the total amount, quality, and configuration of nesting habitat in each year *t*. Nesting carrying capacity ($K_{L,t}$) was assumed to be positively related to the amount of nesting habitat present on landownership *L* in year *t* in a one-to-one manner; for example, a forest stand 100 ha in size would be expected to contain twice as many breeding murrelets as a stand 50 ha in size, all other factors being equal (i.e., nesting habitat quality and configuration). In Washington, a positive association has been observed between radar counts of murrelets flying inland and the amount of late-seral stage forest at the watershed scale, and the slope of this relationship is approximately one (Raphael, Mack & Cooper 2002). Nesting density was assumed to be related to stand-level "habitat quality" based on generalized probabilities of murrelet use that were associated with stages of successional development in DNR-managed forest in southwest Washington (Raphael et al. 2008). Based on DNR's forest inventory, stands were assigned to one of seven nesting habitat quality categories ("Pstage"), non-habitat (Pstage = 0) and six classes of habitat with Pstage values 0.25, 0.36, 0.47, 0.62, 0.89, and 1. Classification was based on stand age, origin (natural vs. planted), and species composition, where (i) older stands were assumed to have greater nesting densities than younger stands, (ii) naturally-regenerated stands (unlike planted) were assumed to be capable of developing as habitat within the analysis period, and (iii) stands dominated by western hemlock (*Tsuga heterophylla*) were assumed to develop into suitable habitat and thus greater nesting densities at an earlier age than stands dominated by Douglas-fir (*Pseudotsuga menziesii*).

Together these three variables were assumed to represent the development of key murrelet nesting habitat characteristics such as large trees with large limbs and complex canopy structure. Pstage 1 is not inventory-based, that value was assigned to stands where murrelet use was observed during DNR-sponsored surveys. In our population model, the Pstage value represented the stand's maximum nesting density where, for example, four acres of Pstage 0.25 provide the same nesting opportunities as one acre of Pstage 1.

Maximum nesting density was also influenced by edge effects, where availability of nest sites (and thus nesting density), was assumed to be lower in portions of stands adjacent to edges with non-habitat. Wind-throw as well as hotter, drier microclimate at the edge of young stands created by timber harvest can lead to the mortality of platform-bearing trees as well as epiphyte mortality that reduces platform abundance in surviving trees (Chen, Franklin & Spies 1992; van Rooyen, Malt & Lank 2011). Edge effects were assumed to occur when a stand of suitable habitat (Pstage > 0) occurred adjacent to a stand dominated by trees < 80' (approximated as <40 years old) and were categorized based on the condition of adjacent young forests as "hard" (<40' tall approximated as <20 years old) or "soft" (40'-80' tall). Empirical values of tree density and suitable platform abundance from van Rooyen et al. (2011) formed the basis for adjustments to nesting density (Pstage) for the two edge types, 0.25 adjacent to hard edges and 0.60 at soft edges. Habitat in small, often linear fragments that were entirely edge, called *Strings* was assumed to have no value. Edge effects on larger habitat patches with areas over 100 meters from edge are assumed to be greatest near edges and decline with distance, generalized to "outer" and "inner" edges within 50 meters and between 50 and 100 meters from edge (Chen et al. 1992). Full effects were assumed to occur in outer edges, half-effects were assumed for inner edges, and "interior" habitat >100 m from edge was assumed to be unaffected. Thus as informed by DNR's spatially-explicit forest inventory, nesting density was estimated for each factorial combination of Pstage (6 classes), edge distance (3 classes: outer, inner, interior), and edge type (hard and soft). This process resulted in 24 combinations of six Pstage classes by edge-distance (outer, inner) and edge-type (hard, soft) plus six Pstage classes in interior habitat providing 30 different nesting density adjustments applied to current and alternative-specific projected future habitat maps. For example, nesting density was assumed to be sixteen times greater in Pstage = 1, interior forest than in Pstage = 0.25 subject to the hard, outer edge effect of 0.25 (16 = 1 / (0.25*0.25). Pstage and edge adjustments for non-DNR lands followed the assumptions of Raphael et al. (2008) and were held constant over the modeling period.

Original nesting carrying capacity estimates (see Appendix A) based on the number of adult female murrelets based on at-sea surveys failed to yield population trajectories consistent with recent ~5% annual declines in the state (Falxa *et al.* 2015). Using deterministic simulations, we found that when we set nesting carrying capacity such that 40% of adult murrelets were non-breeders (i.e. the population was above carrying capacity), initial simulated population declines better approximated recent observed ~5% annual declines. Therefore we set initial nesting carrying capacity ($K_{L,0}$) to equal the number of adult breeders on each landownership *L* ($n_{5,L,0}$), which was 60% of the number of female adult murrelets in year 0 based on a stable age distribution (Table 1). In each subsequent year ($t \geq 1$), carrying capacity $K_{L,t\geq 1}$changed based on projected losses (from harvesting) or gains (through forest growth) in nesting habitat in each Pstage by edge-type and distance combination and the nesting density relationships described above. Moreover, because a single nesting carrying capacity was considered for each landownership that reflected aggregate habitat conditions, we assumed that recruiting murrelets choose nests sites randomly with respect to edge type and Pstage (i.e., they recruit into habitat in proportion to the abundance of potential nest sites it is assumed to provide).

Effects of Forest Conditions on Nest Success ($f_{L,t}$). The model also linked population growth rates to nesting habitat conditions by treating nest success rates (number of female offspring produced per nesting female) in landownership *L* and year *t* ($f_{L,t}$) as a function of the distribution of interior, inner edge, and outer edge forest in the landownership. Nest success was assumed to be greatest where edge effects were absent and to be reduced where nesting habitat occurred adjacent to a hard edge, with inner edges assumed to promote higher nest success than outer edges. Soft edges were assumed to have no influence in nest success (Raphael, Mack & Cooper 2002; Malt & Lank 2009). Estimates of nest success rates in soft- or non-edge influenced forest (0.550) and outer edge (0.380) were drawn from the upper and lower bounds assumed for this parameter in demographic analyses conducted by McShane et al. (2004). An intermediate value of 0.465 was assumed for nest success in inner edge near hard edges. In sum, greater relative amounts of edge habitat under a given management alternative were expected lead to a greater fraction of the population nesting near edges, lower mean nest success, and lower population growth rates.

Forest Management Alternatives

We considered six forest management alternatives, each involving different approaches to timber harvesting and habitat conservation on DNR-managed land in western Washington (see Washington Department of Natural Resources 2016b). Each alternative was built around *long-term forest cover* (LTFC), areas of existing conservation commitments made under the HCP (e.g., high-quality spotted owl habitat, riparian management zones), DNR's Policy for

Sustainable Forests and state law. The alternatives then variously add LTFC to further conserve and restore murrelet habitat. The abundance, configuration, and location of this murrelet-specific LTFC differs among alternatives, reflecting a range of conservation approaches. All alternatives provide for new habitat growth through the life of the HCP. Common among alternatives, initial (t = 0) forest conditions were set to current conditions on DNR-managed lands (DNR database and landscape models of potential murrelet nesting habitat) and other landownerships in Washington (Raphael *et al.* 2016). Projections of future habitat conditions over the 50-year modeling period were conducted by DNR using the Forest Vegetation Simulator (FVS), where differences in harvest and conservation among the management alternatives led to different expected trajectories in the amount, quality and configuration of murrelet nesting habitat on the landscape, and thus differences in carrying capacity and nest success among the alternatives (Figure 2). The six alternatives are more thoroughly defined in DNR (2016) but they, and a baseline scenario (i.e., static forest conditions), are summarized below:

1. **Alternative A** is the "no-action" alternative, approximating continued DNR operations as authorized under the 1997 HCP. This alternative includes approximately 620,000 acres of LTFC, with murrelet-specific conservation including: all occupied sites as delineated by HCP-directed surveys, with a 100-meter buffer; all reclassified habitat in OESF; all reclassified habitat in the Straits, South Coast and Columbia planning units that has not been identified as "released" for harvest under the interim strategy; in the North Puget and South Puget planning units, all suitable habitat that has not been identified as "released" for harvest subject to the 2007 concurrence letters, all newly identified habitat, and all potential habitat that has a P-stage value >0 in decade 0.

2. **Alternative B** focuses on protecting the known locations of marbled murrelet occupied sites on DNR-managed land. Under this alternative, LTFC totals approximately 593,000 acres, and includes occupied sites delineated by the 2008 Science Team recommendations (Raphael *et al.* 2008). This approach results in approximately 16,000 acres more than the HCP delineations used by Alternative A, as well as occupied sites identified by DNR staff in the North and South Puget planning units. This is the only alternative that does not provide buffers on occupied sites.
3. **Alternative C** is designed to protect occupied sites and current habitat as well as grow new habitat over the life of the HCP. LTFC totals approximately 636,000 acres. This alternative contains both marbled murrelet "emphasis areas" and "special habitat areas." Seven emphasis areas from 4,100 to 15,600 acres are identified in strategic landscapes for the purpose of protecting and reducing fragmentation around occupied sites, and developing future marbled murrelet habitat. Twenty special habitat areas, 40 to 8,000 acres, are generally smaller than emphasis areas and are designed to increase murrelet productivity by reducing edge and fragmentation around more isolated occupied sites that are not within an emphasis area. Outside of emphasis or special habitat area boundaries, this alternative will also buffer all other existing occupied sites and will maintain all higher quality habitat (Pstage value 0.47 and greater).
4. **Alternative D** concentrates conservation into thirty-two special habitat areas, 40 to 14,400 acres. LTFC totals approximately 634,000 acres. All acreage within special habitat areas is designated as LTFC. Special habitat areas are designed to increase the productivity of existing occupied sites by increasing habitat abundance and reducing edge effects. They include: strategically located occupied sites with 100-meter buffers;

adjacent P-stage habitat (both existing and expected to develop through 2067); adjacent, non-habitat areas intended to provide security to existing and future habitat (security forests). The boundaries of the special habitat areas were identified based on existing landscape conditions (management history, watershed boundaries, natural breaks or openings). Because of its focus on reducing fragmentation around existing, occupied sites, Alternative D would allow more acres of potential habitat (habitat that has or will develop a P-stage value) to be harvested throughout the analysis area than Alternative C. However, the overall amount of LTFC is similar under Alternatives C and D.

5. **Alternative E** combines the conservation approaches of Alternatives C and D, for a total of approximately 640,000 acres of long-term forest cover. This alternative includes the following murrelet-specific conservation: occupied sites, with 100 meter buffers; all habitat with a P-stage value of 0.47 and greater throughout the analysis area; emphasis areas as designated under Alternative C; special habitat areas as designated under Alternative D (where emphasis areas and special habitat areas overlap, emphasis area will be the designation).

6. **Alternative F** proposes to LTFC apply the conservation recommendations presented in the 2008 Science Team report (Raphael et al. 2008), which evaluated conservation opportunities in the four coastal HCP planning units and recommended the establishment of 45 marbled murrelet management areas of up to 15,500 acres. It also applied the principles of Raphael et al. (2008) to establish 20 similar areas of up to 47,400 acres in the North and South Puget planning units. In total approximately 734,000 acres of LTFC is designated under this alternative. All occupied sites would be protected with a 100-meter buffer. Additionally, all Old Forest in the OESF would receive a 100-meter buffer.

Existing, mapped low quality northern spotted owl habitat in designated owl conservation areas (nesting/roosting/foraging, dispersal and OESF) is included as LTFC (Alternatives A through E only include high quality owl habitat as LTFC).

7. **Baseline** represents a static habitat scenario, where the raw amount of murrelet nesting habitat that presently exists on DNR lands (170,797 acres) remains constant over the 50-year modeling period. Carrying capacity ($K_{1,t}$ = 217) and nest success ($f_{1,t}$ = 0.509) also remain fixed. Although it is biologically unrealistic, the baseline scenario offers a useful benchmark by which to compare scenarios with changing habitat conditions.

In addition to the six proposed alternatives, the DNR and USFWS proposed an additional exploratory analysis which would show how the modeled murrelet population on DNR lands would respond to (i) delayed harvest implementation and (ii) including habitat in “stringers”, where all the habitat is influenced by edge conditions (i.e., no interior habitat), under both *Risk* and *Enhancement* scenarios. These additional exploratory analyses were applied to the existing framework of alternative D (see above), and can be described as follows:

1. **Alternative D – ‘M’** is the exploratory variant of alternative D in which habitat removal was ‘metered’ over two decades as opposed to all habitat harvest occurring in the first decade, as was the case in all six proposed alternatives above. The primary goal of this exploration was to gauge the extent to which slowing the rate of habitat decline in the near-term would allow habitat recovery in LTFC to “compensate” for that harvest. Delaying harvest of habitat could also be part of an expanded mitigation strategy.
2. **Alternative D – ‘S’** is the exploratory variant of alternative D in which P-stage habitat completely influenced by edge conditions (‘stringers’) is credited as viable murrelet

habitat. In the six proposed alternatives above, ‘stringers’ have no habitat value. The primary goal of this exploration was to determine if ‘stringers’ have a net positive or negative effect on murrelet populations. This alternative begins with a higher value for nesting carrying capacity because ‘stringers’ are credited as potential nesting habitat.

For the six primary and two exploratory alternatives, forest conditions on non-DNR lands were assumed to be stationary over the modeling period. While we recognize that habitat conditions on non-DNR lands are not static, we lacked sufficient information for non-DNR lands to project habitat changes over time. Because our modeling objective was to evaluate how changes in habitat conditions on DNR lands may influence murrelet populations over time, it was appropriate to evaluate the range of alternatives in the context of the current conditions on non-DNR lands. Although this assumption is clearly unrealistic, some habitat will be lost to harvest and natural disturbances, and habitat will develop on federal lands reserved from harvest under the Northwest Forest Plan (Raphael et al. 2016), it was adopted because it simplified presentation and interpretation of population responses to changes on DNR-managed land which contain about 15% of murrelet nesting carrying capacity in Washington according to our analytical model.

Model Projections, Stochasticity, and Estimating Risk

Model Projections. We projected the model forward in time as follows:

$$\mathbf{n}_{t+1} = \mathbf{A}_{\boldsymbol{t}} \cdot \mathbf{n}_t$$

where $\mathbf{n}_t$ was a 10 by 1 vector of murrelet abundance in the five stage classes $x = 1,2,\ldots,5$ and two landownerships $L = 1, 2$ in year t, and $\mathbf{A}_t$ was the matrix of vital rates (described above). The vector of population sizes $\mathbf{n}_1$ was:

$$\mathbf{n}_1 = \begin{bmatrix} 83 \\ 52 \\ 46 \\ 145 \\ 217 \\ 472 \\ 293 \\ 260 \\ 819 \\ 1229 \end{bmatrix}$$

where the first five elements represent the number of juveniles, 1-year subadults, 2-year subadults, and adults (nonbreeders and breeders) on DNR lands assuming a stable age distribution. The second five elements would be the number of individuals in each of these stage classes on non-DNR lands under the same sets of assumptions. The number of adults in the nonbreeding and breeding classes (the fourth and fifth elements for each landownership) were allocated based on deterministic carrying capacity simulations (see above).

Incorporating Environmental Stochasticity. The model incorporated the effects of stochasticity by allowing survival and reproductive rates to vary randomly from year to year. After-hatch-year survival rates in year t were selected randomly from a beta distribution. Selecting survival rates from a beta distribution ensured that survival rates fell between 0 and 1. As discussed above, we set the mean value for annual survival for after-year-year murrelets to 0.87 and 0.90 in the *Risk* and *Enhancement* analyses, respectively, based on mark-recapture studies in California (Peery *et al.* 2006). Annual variability in survival has not been estimated rigorously for marbled murrelets, but setting the variance in annual survival $[var(s)]$ to 0.004 resulted in few years with survival < 0.75, and thus provided a reasonable degree of biological realism. Frequent survival rates below 0.75 seemed implausible given the modest annual variability in population size estimated from at-sea surveys (Falxa *et al.* 2015). Juvenile survival in year *t* was set to 70% of after-hatch-year survival such that these two rates are assumed to co-vary perfectly. Stochasticity in reproduction was modeled by first calculating expected fecundity (the number of female juveniles per female adult denoted $m_{1,t}$ and $m_{2,t}$ for DNR and non-DNR lands, respectively) which is simply the product of the expected proportion of females that breeders (b) and nest success ($f_{L,t}$) divided by 2 (because approximately half of fledging juveniles are female). Fecundity was then randomly selected in year *t* from a beta distribution with an expected value of $m_{L,t}$ and a variance $[var(m)]$. An attempt was made to use the variance in reproductive data from central California, but simply using a value of 0.016 for $[var(m)]$ yielded more realistic projections and better model performance. Fecundity on DNR and non-DNR lands was assumed to be perfectly correlated and vary with the same magnitude. Survival and fecundity were assumed to co-vary independently among years since these vital rates appear to be driven by different environmental processes (Peery *et al.* 2006; Becker, Peery & Beissinger 2007). The variances of $[var(s)] = 0.004$ for survival and $[var(m)] = 0.016$ for reproduction resulted in a mean coefficient of variation (CV) in simulated populations over the first 15 years (CV = 0.201) that aligned with expectations based on the process variance observed in murrelet at sea counts in WA from 2001 to 2015 (CV = 0.203), when we used demographic values and nesting carrying capacity that led to approximately 5% annual declines ($s_{\geq 2,L,t}$ = 0.87 and $d_{L,t} = 0$).

Quantifying Population Risk. For each of the management alternatives (see below), we projected

10,000 simulated populations forward in time for t = 50 years (where t = 0 represented present conditions). To assess patterns of risk, we estimated (i) the mean change in population size between t = 0 and 50 and (ii) the "quasi-extinction probability", defined as the proportion of simulated populations where $\sum_{i=1}^{x} n_{x,L,50}$ was lower than subjectively defined quasi-extinction thresholds. Quasi-extinction thresholds were set to one half, one quarter, one eighth, and one sixteenth of the starting population size (i.e., $\sum_{i=1}^{x} n_{x,L,0}$).

Sensitivity Analysis

While the scenario-based analysis of murrelet population viability allowed us to compare potential effects of proposed forest management alternatives, the relative influence of changes in individual habitat classes (e.g., inner edge vs. interior forest) on murrelets was confounded because the alternatives included simultaneous changes in many or all habitat classes each year throughout the 50-year modeling period. We developed a sensitivity analysis to explore the relative influence of each the nine habitat classes (the three edge types and six Pstage categories) on murrelet populations by simulating a change in one habitat class while controlling for effects of other classes. Specifically, we simulated an immediate loss of 10,000 acres of murrelet habitat in year t = 0 within either (*i*) one edge class (e.g., inner edge), where Pstage classes were reduced in proportion to their availability within the focal edge class, or (*ii*) one Pstage class, where edge classes were reduced in proportion to their availability within the focal Pstage class. For example, when exploring model sensitivity to changes in "inner edge", approximately 3,000 of the 10,000-acre simulated loss of "inner edge" habitat occurred within Pstage = 1, which represents its extent (30%) relative to the other Pstage classes within this edge class. We created one additional scenario ("acreage") in which the simulated 10,000-acre loss in habitat occurred proportionally across all 18 edge-Pstage combinations as a basis for comparing the relative influence of habitat amount (raw acreage) vs. habitat quality (e.g., edge conditions, Pstage) on murrelet populations.

We chose 10,000 acres (~5.9% of total raw acreage) because it represented the maximum habitat loss possible while meeting the "proportional loss" constraint of the sensitivity analysis; any larger amount would have required proportional losses to certain habitat classes that exceeded their availability on the landscape. For each of the 10 scenarios in the sensitivity analysis we simulated the 10,000-acre loss of habitat in year 0, ran the population model for 50 years under the *Enhancement* parameterization, and repeated 10,000 simulations using SAS 9.3. We then compared the average percent population change on DNR lands after 50 years for all scenarios and compared these changes to a baseline scenario in which no habitat loss occurred. Results of the sensitivity analysis should be interpreted as the relative (as opposed to absolute) influence of different habitat classes (raw acreage, edge, Pstage) on murrelet population growth in the region.

RESULTS

Forest Management Scenarios

All six of the primary management alternatives were projected to result in more nesting habitat, a greater carrying capacity, and expected nest success on DNR lands at the end of the 50-year modeling period (Figure 2a-c). Nevertheless, some alternatives differed from one another considerably with respect to all three metrics (Figure 2a-c). The most optimistic scenario for change in raw murrelet habitat was alternative F, in which habitat increased by 58% over the 50-

year modeling period. In contrast, the most pessimistic scenario for change in raw habitat was alternative B, which yielded an initial decline in habitat over the first decade but resulted in gradual increases thereafter, ending with a net 9% increase in habitat after 50 years. In terms of raw habitat change, the remaining alternatives fell between B and F (Figure 2a). Similarly, differences in nesting carrying capacity (K) among the six alternatives were bounded on the upper end by alternative F and on the lower end by alternative B. Carrying capacity increased by 137% under alternative F, while alternative B ended with a net 30% increase after 50 years following an initial decline. Carrying capacities for the remaining alternatives always fell between B and F (Figure 2b). Mean nest success, which contributed to estimates of annual fecundity, was similarly bounded by alternatives B (lower nest success) and F (higher nest success) with all other alternatives falling between the two (Figure 2c). In contrast to the six alternatives, the baseline scenario did not vary temporally but was structured such that the amount of raw habitat, nesting carrying capacity, and mean nest success remained constant over the 50-year modeling period.

Changes to raw habitat, nesting carrying capacity, and nest success for the two exploratory variants of alternative D (D –'S' and D – 'M') can be found in Figure 2d-f. Because alternative D – 'S' credited 'stringers' as potential murrelet nesting habitat, it had a greater amount of raw habitat and carrying capacity than either D or D – 'M' (Figure 2d-e). However, because 'stringers' are entirely adjacent to edge thus of lower habitat quality, the estimated average nest success for alternative D – 'S' was lower than any other scenario in this analysis (Figure 2f). Alternative D – 'M' tracked alternative D closely except over the first two decades for raw habitat and carrying capacity, because alternative D – 'M' was designed to implement a delayed harvesting strategy (Figure 2d-e).

Population Viability Analysis

Risk analysis, DNR population. In the *Risk* analysis, we observed considerable variation in the probability of the murrelet population on DNR lands reaching quasi-extinction thresholds across the six management alternatives and baseline scenario (Figure 3). The probability of murrelet populations on DNR lands reaching 1/2 their initial size after 50 years ranged from 0.8417 (alternative F) to 0.9721 (alternative B). Alternatives F and B continued to define the boundaries of quasi-extinction probabilities for smaller thresholds: at 1/4 of initial N, quasi-extinction probability ranged from 0.4515 (alternative F) to 0.8170 (alternative B); at 1/8 of initial N, quasi-extinction probability ranged from 0.1092 (alternative F) to 0.4203 (alternative B); and at 1/16 of initial N, quasi-extinction probability ranged from 0.0108 (alternative F) to 0.0974 (alternative B). A complete list of quasi-extinction probabilities for all alternatives is provided in Table 2.

Mean female population size on DNR lands declined from 542 individuals to 174.7 (most optimistic) and 95.4 (most pessimistic) under alternatives F and B representing a 67.7% and 82.4% decline in population size, respectively, after 50 years. Mean female population size for the remaining alternatives (as well as the baseline scenario) fell between that of alternatives F and B after 50 years (Figure 4). A complete list of mean female population sizes at 10-year intervals across the 50-year modeling period is provided in Table 3.

Risk analysis, Washington population. In the *Risk* analysis, quasi-extinction probabilities for the Washington murrelet population were much more tightly clustered among the management alternatives (Figure 5). Projections of risk were presumably relatively uniform because modeled management actions were limited to DNR lands, which contained a relatively small portion

(~15%) of carrying capacity for murrelets nesting in the state. The probability of the Washington murrelet population reaching 1/2 of its initial size after 50 years ranged from 0.7978 (alternative F) to 0.8302 (alternative B). For the remaining quasi-extinction thresholds, alternative F generally formed the lower bound and alternative B formed the upper bound. At 1/4 of initial N, quasi-extinction probability ranged from 0.3297 (alternative F) to 0.3618 (alternative B); at 1/8 of initial N, quasi-extinction probability ranged from 0.0538 (alternative F) to 0.0614 (alternative B). At 1/16 of initial N, quasi-extinction probability ranged from 0.0022 (alternative C) to 0.0042 (alternative F), although the difference between these probability estimates represents only 20 of 10,000 simulations. A complete list of quasi-extinction probabilities for all alternatives is provided in Table 2.

Mean female population size on all lands in Washington declined from 3,616 to 1,091 (most optimistic) and 1,076 (most pessimistic) under alternatives F and B (similar to the DNR population, see above) representing a 69.8% and 71.3% decline in population size, respectively, after 50 years. Mean female population size among the remaining alternatives (as well as the baseline scenario) fell between that of alternatives F and B after 50 years (Figure 6). A complete list of mean female population sizes at 10-year intervals across the 50-year modeling period is provided in Table 3.

Enhancement analysis, DNR population. In the *Enhancement* analysis, quasi-extinction probabilities were lower on DNR lands than in the *Risk* analysis (Figure 7). The probability of murrelet populations on DNR lands reaching 1/2 their initial size after 50 years (in the absence of dispersal among land ownerships) ranged from 0.0768 (alternative F) to 0.3462 (alternative B). At 1/4 of initial N, quasi-extinction probabilities among alternatives ranged from 0.0049 (alternative F) to 0.0412 (alternative B); at 1/8 and 1/16 of initial N, quasi-extinction probability was nearly equal to zero across all alternatives (i.e. 10 or fewer of 10,000 simulations reached quasi-extinction thresholds for all alternatives). A full table of quasi-extinction probabilities for all alternatives is found in Table 2.

With the exception of the baseline scenario, in which female population size continued to decline over the 50-year modeling period, all management alternatives resulted in a murrelet population trajectory characterized by an initial decline for the first 10-20 years followed by a gradual and sustained increase through the end of the modeling period (Figure 8). Female population size on DNR lands increased from 542 individuals to 589.7 (most optimistic) and declined to 199 (most pessimistic) under alternatives F and B representing a 8.8% increase and 39.4% decline in population size, respectively, after 50 years. Mean female population size among the remaining alternatives fell between that of alternatives F and B after 50 years (Figure 8). A complete list of mean female population sizes at 10-year intervals across the 50-year modeling period is provided in Table 3.

Enhancement analysis, Washington population. Quasi-extinction probabilities among alternatives for the Washington murrelet population were considerably lower in the *Enhancement* than the *Risk* analysis (Figure 9). The probability of the Washington murrelet population reaching 1/2 of its initial size after 50 years ranged from 0.0610 (alternative F) to 0.0903 (alternative B), with the remaining alternatives yielding quasi-extinction probabilities between F and B. Quasi-extinction probability was nearly equal to zero for all other thresholds among all alternatives (i.e. fewer than 30 of 10,000 simulations reached quasi-extinction thresholds for all alternatives). A complete list of quasi-extinction probabilities for all alternatives is provided in Table 2.

In contrast to the *Risk* analysis, in which the Washington murrelet population followed a relatively steep and steady decline throughout the 50-year modeling period, female population size in the *Enhancement* analysis declined for 20-30 years but then remained approximately stable for the remainder of the modeling period across all alternatives (Figure 10). Female population size in the state of Washington declined from 3,616 individuals to 2,663 (most optimistic) and 2,367.7 (most pessimistic) individuals under alternatives F and B (similar to the DNR population, see above) representing a 26.4% and 34.5% decline in population size, respectively, after 50 years. Mean female population size among the remaining alternatives fell between that of alternatives F and B after 50 years (Figure 10). A complete list of mean female population sizes at 10-year intervals across the 50-year modeling period is provided in Table 3.

Exploratory analyses with variants of alternative D. We evaluated the exploratory variants of alternative D under the *Risk* and *Enhancement* scenarios for DNR lands only. In the *Risk* analysis, quasi-extinction probabilities were always highest for the D – 'S' alternative compared with alternatives D and D – 'M' (Figure 11, Table 4). The probability of the murrelet population on DNR lands reaching 1/2 its initial population size after 50 years was highest for alternative D – 'M' (0.9378) followed by alternative D (0.9315) and alternative D – 'S' (0.8893). At 1/4 of initial N, the quasi-extinction probability was again higher for alternative D – 'M' (0.6592) compared to alternative D (0.6393) and D – 'S' (0.5474) and the same pattern continued at 1/8 of initial N (Figure 11, Table 4). Female population size declined from 542 individuals to 151.3, 129.9, and 125.7 individuals under alternatives D – 'S', D, and D – 'M', respectively, after 50 years (Figure 12). A complete list of quasi-extinction probabilities is provided in Table 4, and mean female population sizes at 10-year intervals is provided in Table 5.

In the *Enhancement* analysis, quasi-extinction probability was generally highest for alternative D. At 1/2 of initial N, quasi-extinction probability was 0.1701 for alternative D followed by alternative D – 'M' (0.1419) and D – 'S' (0.1071). This pattern persisted at 1/4 of initial N but the differences among scenarios was smaller. At 1/8 and 1/16 of initial N, quasi-extinction probability was nearly zero for all three alternatives (Figure 13, Table 4). Mean female population size declined from 542 individuals to 537.5, 451.1, and 436.2 individuals under alternatives D – 'S', D – 'M', and D, respectively, after 50 years (Figure 14, Table 5). A complete list of quasi-extinction probabilities is provided in Table 4, and mean female population sizes at 10-year intervals is provided in Table 5.

Sensitivity Analysis

Murrelet population growth was most sensitive to changes in the highest Pstage (habitat quality) classes 1 and 0.89; reducing the prevalence of these habitat classes on the landscape by 10,000 acres resulted in population estimates that were 7.5% and 5.0% lower than the baseline (static habitat) scenario after 50 years, respectively. Removing 10,000 acres of murrelet habitat across the 18 Pstage-edge class combinations in proportion to their availability ('acreage') resulted in a population estimate 4.0% lower than the baseline, which had a slightly stronger effect on murrelet population growth than removing 10,000 acres of interior forest (3.9% lower than baseline). Removing Pstages 0.62, 0.47, inner edge, and outer edge resulted in final populations 3.4%, 1.6%, 2.9%, and 1.6% lower than the baseline scenario, respectively. Removing 10,000 acres of Pstages 0.25 and 0.36 caused minor (<0.5%) changes to murrelet populations compared to the baseline (Figure 15).

DISCUSSION

Implications for Population Risk and Enhancement

We developed a stochastic, demographic meta-population model to evaluate the potential effects of alternative forest management strategies for DNR lands on the viability of marbled murrelet populations in the state of Washington. Moreover, we carried out parallel *Risk* and *Enhancement* analyses to help assess the extent to which proposed management actions may increase population risk or the likelihood of population recovery given that it was not possible to assess both of these HCP considerations with a single analysis. Only one alternative (B) was projected to reduce murrelet population size compared to the Alternative A ("no-action"; i.e., continued management under the 1997 HCP guidelines) if murrelet populations continue to decline as a result of environmental factors unrelated to changes in nesting habitat quality and quantity (i.e., under the *Risk* analysis). Conversely, our findings suggest that all other alternatives (C – F) are expected to lead to larger murrelet populations than alternative A should the population continue to decline as a results of these factors. Similarly, alternative B appeared to provide less capacity for murrelet populations to increase in size than alternative A, whereas alternatives C through F led to larger murrelet populations than alternative A, under the assumption that environmental stressors likely impacting murrelets are ameliorated (i.e., in the *Enhancement Analysis*). The same patterns were generally observed for quasi-extinction probabilities, although differences between alternative A and the other alternatives were not quite as consistent as they were for mean projected population size.

Differences in ending population size among the proposed alternatives were greater when inference was limited to the "DNR population" as opposed to the entire state of Washington, particularly when differences were considered on a percentage basis. Compared to the "no-action" alternative (A), almost 1.5 times as many murrelets were expected to occur on DNR lands under alternative F according to both *Risk* and *Enhancement* analyses (i.e., almost a 50% difference). While percentage differences in ending population sizes among alternatives were greater for the DNR "population" than they were for the entire Washington population, differences in the number of individuals among alternatives were more similar at the two spatial scales. For example, the difference in mean ending population size between the "best" (alternative F) and "no-action" (alternative A) alternatives was 51.7 for DNR lands and 34.1 individuals for the state of Washington in the *Risk* analysis. Thus, differences in abundance among the alternatives at the state level were largely the result of changes in abundance on DNR lands, which were included in state level projections of population sizes.

Comparison of Individual Alternatives

For both *Risk* and *Enhancement* analyses, alternative B consistently resulted in the lowest projected murrelet numbers after the 50-year simulation period, and generally had the highest quasi-extinction probabilities. Moreover, and as discussed above, alternative B was also the only proposed alternative that resulted in lower murrelet numbers than the "no-action" alternative (alternative A) in both *Risk* and *Enhancement* analyses for both DNR lands and the state of Washington. This finding was, to a certain extent, consistent with the fact that alternative B would protect the least (593,000 acres) of LTFC among all alternatives. By comparison, the "no-action" alternative (A) would involve the protection of 620,000 acres of LTFC. Compared to the "no-action" alternative (see above for details), alternative B focused only on protecting the known locations of marbled murrelet occupied sites on forested state trust lands, and was the only alternative that did not provide buffers on occupied sites.

In contrast, alternative F consistently resulted in the highest projected murrelet numbers after the 50-year simulation period for both *Risk* and *Enhancement* analyses. At the state level, alternative F was projected to lead to an average of 53.3 and 295.3 more female murrelets than alternative B under the *Risk* and *Enhancement* scenarios, respectively. Alternative F also generally had the lowest quasi-extinction probabilities. Under alternative F, 94,000 more acres (734,000 acres total) of LTFC than any other alternative (alternative E being the second most conservative, involving the protection of 640,000 acres). Compared with others, alternative F is distinct in that it proposes the establishment of more extensive conservation areas in most planning units and includes existing, mapped low quality northern spotted owl habitat in designated owl conservation areas as LTFC (alternatives A through E only include high quality owl habitat as LTFC).

In sum, alternative B posed the greatest risk to murrelet populations and alternative F provided the greatest capacity to enhance murrelet populations. Importantly, our population simulations suggested that alternatives F and B were generally the “best” and “worst”, respectively, with respect to murrelet population viability for DNR lands and the state of Washington in both the *Risk* and *Enhancement* analyses. This result is useful from a forest management perspective, because whether or not unrelated chronic environmental stressors are alleviated (i.e., the major difference in model assumptions between *Risk* and *Enhancement* analyses), alternative F is predicted to have the most positive effect on murrelet populations over the next 50 years because it provides the greatest amount of habitat and carrying capacity with the least edge effects.

The exploratory analysis comparing alternative D with a delayed harvest variant (D – ‘M’) and a variant that included ‘stringers’ as potential murrelet habitat (D – ‘S’) provides several interesting observations and insights. First, while the quasi-extinction probability was generally highest for alternative D – ‘M’ in the *Risk* analysis, the quasi-extinction probability was highest for alternative D in the *Enhancement* analysis. By comparison, alternative D – ‘S’ consistently had the lowest quasi-extinction probabilities and highest average female population size across both analyses. This result was unsurprising given that alternative D – ‘S’ had a comparably larger amount of raw habitat and a higher carrying capacity than the other alternatives (Figure 2d-e) because ‘stringers’ were credited as murrelet habitat which, despite lowering mean nest success because of increased edge effects (Figure 2f), resulted in a net positive for murrelet populations. This suggests that if our assumptions about edge effects are sound, small habitat patches with high levels of edge effects may not pose a direct population risk when they occur in combination with more extensive amounts of intact forest habitat. Less clear is why ‘metering’ harvest activities – such that their implementation occurred over two decades as opposed to one (alternative D – ‘M’) – resulted in higher quasi-extinction probability in the *Risk* analysis and a lower quasi-extinction probability in the *Enhancement* analysis. This result is more nuanced for mean female population size, which remained higher for D – ‘M’ in both analyses compared to alternative D over the first two decades of simulation, remaining above D in the *Enhancement* analysis (Figure 12) but falling below D in the *Risk* analysis for all years thereafter (Figure 10). While the factors driving these differences are not entirely clear, we suspect that a delayed harvest under the *Enhancement* scenario, which was parameterized with more optimistic population vital rates, may have provided a greater capacity for murrelet population growth than in the *Risk* analysis. Regardless, the influence of delayed harvest on murrelets in our model appeared to be relatively small, resulting in an average of only 4.2 fewer individuals in the *Risk* analysis and 14.9 more individuals in the *Enhancement* analysis compared to the standard 10-year harvest schedule (Table 5).

Sensitivity of Marbled Murrelet Populations to Habitat Change

The sensitivity analysis suggested that murrelet populations were most sensitive to changes in the amount of high-quality nesting habitat (P-stages 0.89 and 1), which exerted a stronger influence on modeled trajectories than changes in either the raw amount of nesting habitat or edge conditions (habitat configuration). Murrelet nests are typically located in large, decadent platform-bearing trees which, because of their age and economic value are relatively uncommon across the landscape and likely represent a limiting factor with respect to murrelet population densities (Burger 2001; Raphael, Mack & Cooper 2002). Because the highest Pstage classes represent forest stands with greater densities of platform-bearing trees suitable for nesting and presumably higher levels of murrelet use, it is therefore unsurprising that murrelet population growth appeared to be more sensitive to loss of the highest-quality habitat which, acre-for-acre, has a disproportionate influence on the population density of breeding-age murrelets. While change in habitat configuration (edge) was linked to nest success as well as nesting density in our analytical model, it nevertheless had a relatively modest influence on murrelet population growth presumably because the proportion of interior forest is considerably higher for the highest Pstages (51%) than the other categories (29%) on DNR-managed land (Washington Department of Natural Resources & US Fish and Wildlife Service 2016).

Caveats and Future Directions

Our model was parameterized with published demographic information collected for marbled murrelets from intensive field studies and structured based on a reasonable understanding and interpretation of murrelet ecology and nesting habitat needs. Moreover, the reproductive component of the model was informed by detailed assessments forest conditions in the state of Washington, and particularly on DNR lands. However, changes in climate and other environmental factors, particularly in the marine environment, that were not considered explicitly here likely also impact murrelet population dynamics and will continue to do so in the future. For example, unanticipated increases in marine stressors could further diminish murrelet populations regardless of projected increases to the amount and quality of nesting habitat. Nevertheless, the scope of this analysis was to estimate the potential and relative effect of habitat management alternatives using parameters largely under the control of land management agencies. Future areas of research could involve the development of a population model that more explicitly links risk to, for example, potential future changes in climate, oil spills, fisheries interactions, and predators.

As is always the case in PVA analyses, our model required a number of simplifying assumptions. We assumed that murrelets recruiting into the breeding population (e.g., 2-year subadults) selected nesting habitat independent of quality. Rather, individuals recruited into habitat types “proportionally” such that if, for example, five murrelets recruited into the breeding population, four would do so into Pstage = 1 habitat and one would recruit into Pstage = 0.25 habitat, even if additional nests were available in Pstage = 1 habitat. Second, we assumed that breeders remained in the same landownership unless they were displaced by habitat loss, and thus assumed that only nonbreeding individuals recruiting into the breeding population dispersed among landownerships. In other words, natal dispersal was permitted but, in the absence of habitat loss, breeding dispersal was not. Third, we assumed that displaced breeders (by habitat loss) could become nonbreeders for at least one year (for analytical tractability) and that displaced breeders could become breeders again if nesting habitat was available the year after they became nonbreeders. All of these aspects of murrelet breeding ecology are not well understood, and violations of associated assumptions could influence inferences regarding risk to the population.

Population viability analyses range from simple count-based approaches to more complicated spatially-explicit demographic meta-population approaches (Morris & Doak 2002). Here, we used a two-population model (DNR vs non-DNR lands) as a simplification of the complex spatial arrangement of murrelet nesting habitat in Washington given time and budgetary constraints, this simplification being agreed upon by DNR and FWS. However, the spatial arrangement of murrelet nesting habitat likely plays an important role in murrelet movement and dispersal processes throughout the state. Future efforts using spatially-explicit models could provide geographically-targeted (local) estimates of risk, prioritize stands for conservation and management, and generate more realistic insights into how changes in the spatial arrangement of nesting habitat may influence regional murrelet population viability. However, uncertainty about the landscape ecology of murrelet habitat selection and use as well as dispersal processes could obscure inference from such an effort. Finally, we note that results from PVA analyses such as ours typically constitute one of many sources of information (e.g., habitat mapping, expert opinion, etc.) that can inform species conservation and land management decisions and we recommend that they be treated as such.

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TABLES AND FIGURES

Table 1. Parameter values used is in the marbled murrelet meta-population model.

Parameter	Analysis	DNR	non-DNR	Reference/Justification
Initial (female) population size ($n_{x,L,0}$)	Both	$\sum_{i=1}^{x} n_{x,1,0} = 542$	$\sum_{i=1}^{x} n_{x,2,0} = 3{,}074$	Falxa *et al.* (2015); Lance and Pearson (2015)
Initial (female) adult non-breeders ($n_{4,L,0}$)	Both	$n_{4,1,0} = 145$	$n_{4,2,0} = 819$	40% of adult females begin as non-breeders because the population is above carrying capacity
Initial (female) adult breeders ($n_{5,L,0}$)	Both	$n_{5,1,0} = 217$	$n_{5,2,0} = 1{,}229$	
Mean 1-year old survival rate ($s_{1,L,t}$)	Both	$s_{1,1,t} = s_{2,1,t} \cdot 0.7$	$s_{1,2,t} = s_{2,2,t} \cdot 0.7$	Peery *et al.* (2006a, b)
Mean >1-year old survival rates ($s_{\geq 2,L,t}$)	*Risk*	$s_{2,1,t}, .., s_{5,1,t} = 0.87$	$s_{2,2,t}, .., s_{5,2,t} = 0.87$	Peery *et al.* (2006a, b)
	Enhancement	$s_{2,1,t}, .., s_{5,1,t} = 0.90$	$s_{2,2,t}, .., s_{5,2,t} = 0.90$	Peery *et al.* (2006a, b)
Variance in survival rates	Both	$var(s) = 0.004$	$var(s) = 0.004$	Yields coefficient of variation (CV) in simulated populations similar to process CV in population estimates from at-sea surveys
Maximum dispersal rate ($d_{L,t}$)	*Risk*, *Enhancement* (WA population	$d_{1,t} = 0.85$	$d_{2,t} = 0.15$	Equal to proportion of murrelet habitat on DNR and non-DNR lands, lower if

	only)			number of dispersers exceeds availability of nest sites in other landownership
	Enhancement (DNR population only)	$d_{1,t} = 0$	$d_{2,t} = 0$	Assumes DNR and non-DNR populations are demographically independent
Proportion of breeders (possess a nest site) that breed per year (b)	Both	$b = 0.90$	$b = 0.90$	Peery *et al.* (2004)
Mean nest success rate ($f_{L,0}$)	Both	$f_{1,0} = 0.5090$ $f_{1,\geq 1}$ varies by management alternative	$f_{2,0} = 0.5418$ $f_{2,\geq 1}$ remains constant	See Appendix A
Fecundity rate ($m_{L,t}$)	Both	$m_{1,t} = \frac{b \cdot f_{1,t}}{2}$	$m_{2,t} = \frac{b \cdot f_{2,t}}{2}$	
Variance in fecundity rate	Both	$var(m) = 0.016$	$var(m) = 0.016$	Yields coefficient of variation (CV) in simulated populations similar to process CV in population estimates from at-sea surveys
Carrying capacity (number of nests) ($K_{L,t}$), scaled	Both	$K_{1,0}$=217 $K_{1,\geq 1}$ varies by management alternative	$K_{2,0} = 1{,}229$ $K_{2,\geq 1}$ remains constant	See Appendix A

Table 2. Quasi-extinction probabilities (proportion of 10,000 simulations that reached a specified fraction of initial population size) for proposed forest management alternatives (A – F) under the *Risk* and *Enhancement* analyses. Note that a quasi-extinction probability of 0.0001 represents 1 single outcome of 10,000 simulations.

Risk - DNR lands

	Fraction of Initial Population Size			
Alternative	1/16	1/8	1/4	1/2
A	0.0479	0.2624	0.6617	0.9420
B	0.0974	0.4203	0.8170	0.9721
C	0.0126	0.1508	0.5391	0.9003
D	0.0404	0.2361	0.6393	0.9315
E	0.0160	0.1485	0.5402	0.8903
F	0.0108	0.1092	0.4515	0.8417
Baseline	0.0198	0.1670	0.5980	0.9363

Risk - Washington

	Fraction of Initial Population Size			
Alternative	1/16	1/8	1/4	1/2
A	0.0033	0.0605	0.3350	0.8201
B	0.0035	0.0614	0.3618	0.8302
C	0.0022	0.0553	0.3387	0.8066
D	0.0040	0.0562	0.3418	0.8168
E	0.0030	0.0554	0.3418	0.8062
F	0.0042	0.0538	0.3297	0.7978
Baseline	0.0044	0.0553	0.3367	0.8134

Enhancement - DNR lands

	Fraction of Initial Population Size			
Alternative	1/16	1/8	1/4	1/2
A	0	0.0006	0.0180	0.1950
B	0.0001	0.0010	0.0412	0.3462
C	0	0.0001	0.0095	0.1271
D	0	0.0004	0.0138	0.1701
E	0	0.0001	0.0088	0.1226
F	0	0.0004	0.0049	0.0768
Baseline	0	0.0008	0.0139	0.2355

Enhancement - Washington

	Fraction of Initial Population Size			
Alternative	1/16	1/8	1/4	1/2
A	0	0	0.0029	0.0710
B	0	0.0001	0.0024	0.0903
C	0	0	0.0018	0.0669
D	0	0.0001	0.0028	0.0754
E	0	0	0.0022	0.0650
F	0	0	0.0022	0.0610
Baseline	0	0	0.0029	0.0799

Table 3. Projected mean population sizes (average of 10,000 simulations) at each 10-year interval for proposed forest management alternatives (A – F) in the *Risk* and *Enhancement* analyses.

Risk - DNR lands

Alternative	Year of Simulation 0	10	20	30	40	50
A	542	294.0	219.6	181.2	149.8	123.0
B	542	257.8	165.3	139.5	115.9	95.4
C	542	340.6	268.8	222.3	183.6	150.7
D	542	299.4	229.1	190.8	158.0	129.9
E	542	341.6	274.7	227.7	187.5	153.9
F	542	381.4	314.1	258.9	213.4	174.7
Baseline	542	338.0	259.1	207.1	167.1	134.9

Risk - Washington

Alternative	Year of Simulation 0	10	20	30	40	50
A	3616	2303.9	1813.1	1495.5	1254.1	1057.8
B	3616	2271.5	1765.0	1468.6	1229.5	1038.6
C	3616	2337.2	1843.4	1524.3	1279.4	1077.6
D	3616	2313.0	1821.5	1507.5	1263.6	1066.4
E	3616	2327.2	1853.9	1534.3	1285.7	1083.2
F	3616	2353.9	1873.6	1548.5	1298.3	1091.9
Baseline	3616	2327.6	1834.2	1515.5	1268.0	1064.4

Enhancement - DNR lands

Alternative	Year of Simulation 0	10	20	30	40	50
A	542	393.2	342.7	349.8	375.4	405.5
B	542	354.9	275.9	276.9	302.1	328.4
C	542	419.9	391.9	408.1	445.1	481.7
D	542	397.0	354.4	367.8	401.8	436.2
E	542	423.3	401.1	418.5	455.4	490.5
F	542	466.8	466.4	495.6	540.5	589.7
Baseline	542	418.8	374.3	353.4	340.4	333.8

Enhancement - Washington

Alternative	Year of Simulation 0	10	20	30	40	50
A	3616	2858.1	2584.9	2488.1	2469.7	2470.2
B	3616	2807.7	2512.0	2410.8	2371.8	2367.7
C	3616	2889.4	2636.0	2542.3	2528.8	2541.7
D	3616	2856.1	2596.3	2507.0	2477.0	2481.2
E	3616	2884.9	2639.6	2553.8	2534.2	2554.9
F	3616	2923.3	2714.1	2637.0	2638.7	2663.0
Baseline	3616	2874.7	2631.0	2507.5	2437.5	2391.9

Table 4. Quasi-extinction probabilities (proportion of 10,000 simulations that reached a specified fraction of initial population size) for alternative D and two variants D - 'M' and D - 'S' under *Risk* and *Enhancement* scenarios on DNR lands. Note that a quasi-extinction probability of 0.0001 represents 1 simulated population reaching a given threshold.

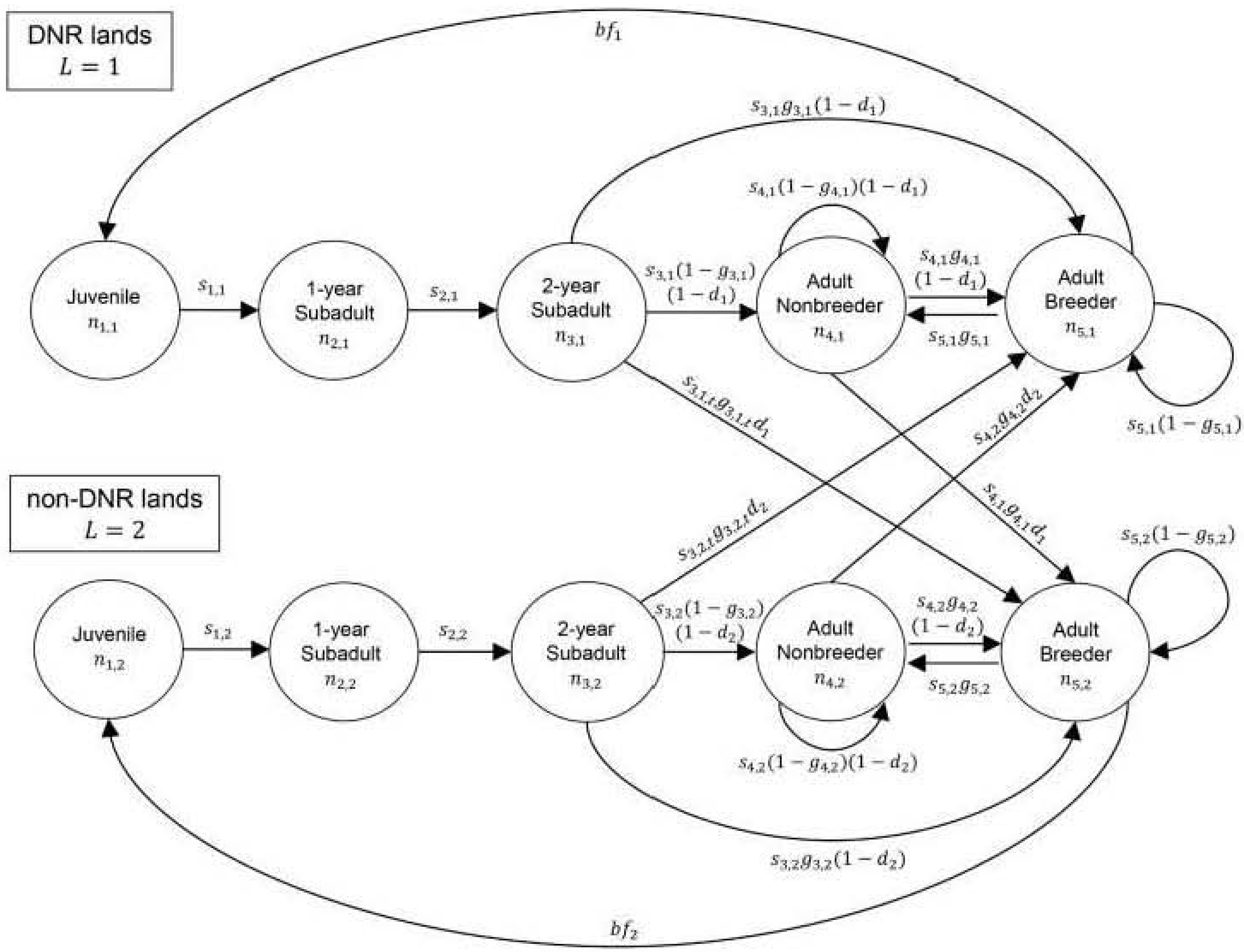
	Risk - DNR lands			
	Fraction of Initial Population Size			
Alternative	1/16	1/8	1/4	1/2
D	0.0404	0.2361	0.6393	0.9315
D – 'M'	0.0277	0.2418	0.6592	0.9378
D – 'S'	0.0286	0.1720	0.5474	0.8893

	Enhancement – DNR Lands			
	Fraction of Initial Population Size			
Alternative	1/16	1/8	1/4	1/2
D	0	0.0004	0.0138	0.1701
D – 'M'	0.0001	0.0004	0.0097	0.1419
D – 'S'	0	0.0003	0.0066	0.1071

Table 5. Projected mean population sizes (average of 10,000 simulations) at each 10-year interval for alternative D and two variants D - ‘M’ and D - ‘S’ under *Risk* and *Enhancement* scenarios on DNR lands.

	Risk - DNR lands Year of Simulation					
Alternative	0	10	20	30	40	50
D	542	299.4	229.1	190.8	158.0	129.9
D – ‘M’	542	341.2	224.4	184.7	153.0	125.7
D – ‘S’	542	357.6	282.3	230.2	187.4	151.3

	Enhancement – DNR lands Year of Simulation					
Alternative	0	10	20	30	40	50
D	542	397.0	354.4	367.8	401.8	436.2
D – ‘M’	542	423.5	376.6	384.4	416.8	451.1
D – ‘S’	542	462.7	434.3	455.1	497.1	537.5



DNR lands
$L = 1$
bf_1
$s_{3,1}g_{3,1}(1-d_1)$
$s_{4,1}(1-g_{4,1})(1-d_1)$
Juvenile
$n_{1,1}$
$s_{1,1}$
1-year Subadult
$n_{2,1}$
$s_{2,1}$
2-year Subadult
$n_{3,1}$
$s_{3,1}(1-g_{3,1})(1-d_1)$
Adult Nonbreeder
$n_{4,1}$
$s_{4,1}g_{4,1}(1-d_1)$
$s_{5,1}g_{5,1}$
Adult Breeder
$n_{5,1}$
$s_{5,1}(1-g_{5,1})$
$s_{3,1,t}g_{3,1,t}d_1$
$s_{4,2}g_{4,2}d_2$
$s_{4,1}g_{4,1}d_1$
$s_{3,2,t}g_{3,2,t}d_2$
non-DNR lands
$L = 2$
$s_{5,2}(1-g_{5,2})$
Juvenile
$n_{1,2}$
$s_{1,2}$
1-year Subadult
$n_{2,2}$
$s_{2,2}$
2-year Subadult
$n_{3,2}$
$s_{3,2}(1-g_{3,2})(1-d_2)$
Adult Nonbreeder
$n_{4,2}$
$s_{4,2}g_{4,2}(1-d_2)$
$s_{5,2}g_{5,2}$
Adult Breeder
$n_{5,2}$
$s_{4,2}(1-g_{4,2})(1-d_2)$
$s_{3,2}g_{3,2}(1-d_2)$
bf_2

Figure 1. Life-cycle diagram for the demographic meta-population model used to evaluate the potential effects of Washington DNR's management alternatives on marbled murrelets. $n_{x,L}$ represents the number of female murrelets; $s_{x,L}$ represents the survival probability; $g_{x,L}$ represents the transition probability; d_L represents the dispersal probability; b represents the breeding probability; f_L represents nest success rate; the subscript x = 1,2,…,5 represents stage classes juvenile, 1-year subadult, 2-year subadult, adult nonbreeder, and adult breeder, respectively; the subscript L = 1, 2 represents DNR and non-DNR lands, respectively. Note that time t was not included in the diagram for simplicity.

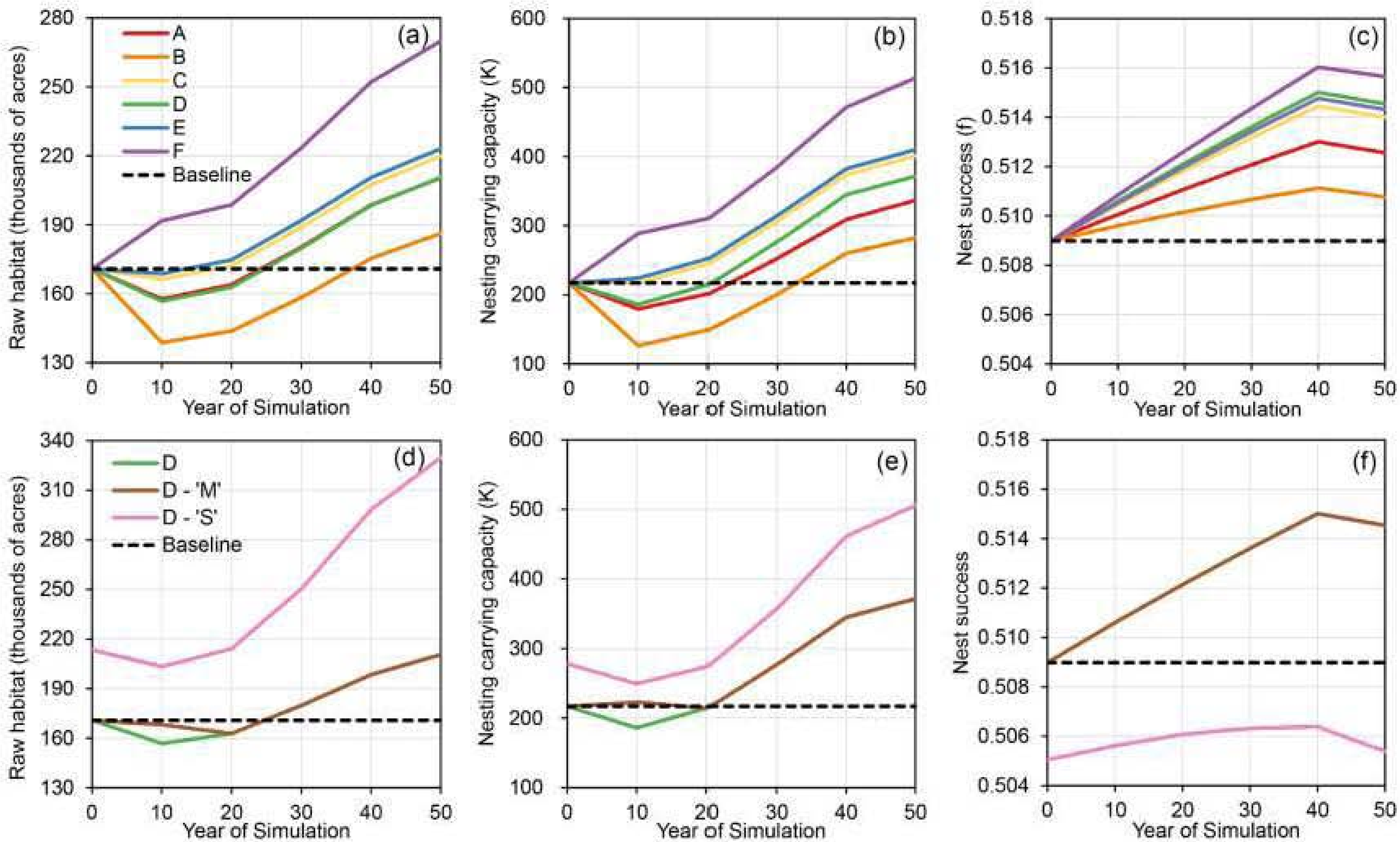

(a)
(b)
(c)
(d)
(e)
(f)
A
B
C
D
E
F
Baseline
D
D - 'M'
D - 'S'
Baseline
Raw habitat (thousands of acres)
Nesting carrying capacity (K)
Nest success (f)
Nest success
Year of Simulation

Figure 2. Forest management alternatives proposed by the Washington DNR and the U.S. Fish and Wildlife Service. The raw amount of nesting habitat, carrying capacity, and nest success on DNR-managed lands for each of the primary alternatives (A – F) over the modeling period are presented in panels a – c, respectively. The same measures for the exploratory alternatives (D – ‘M’ and D – ‘S’) are shown in panels d – f, and include alternative D for the purposes of comparison.

Note: In panel F nest success is not significantly different between Alt D and D-M

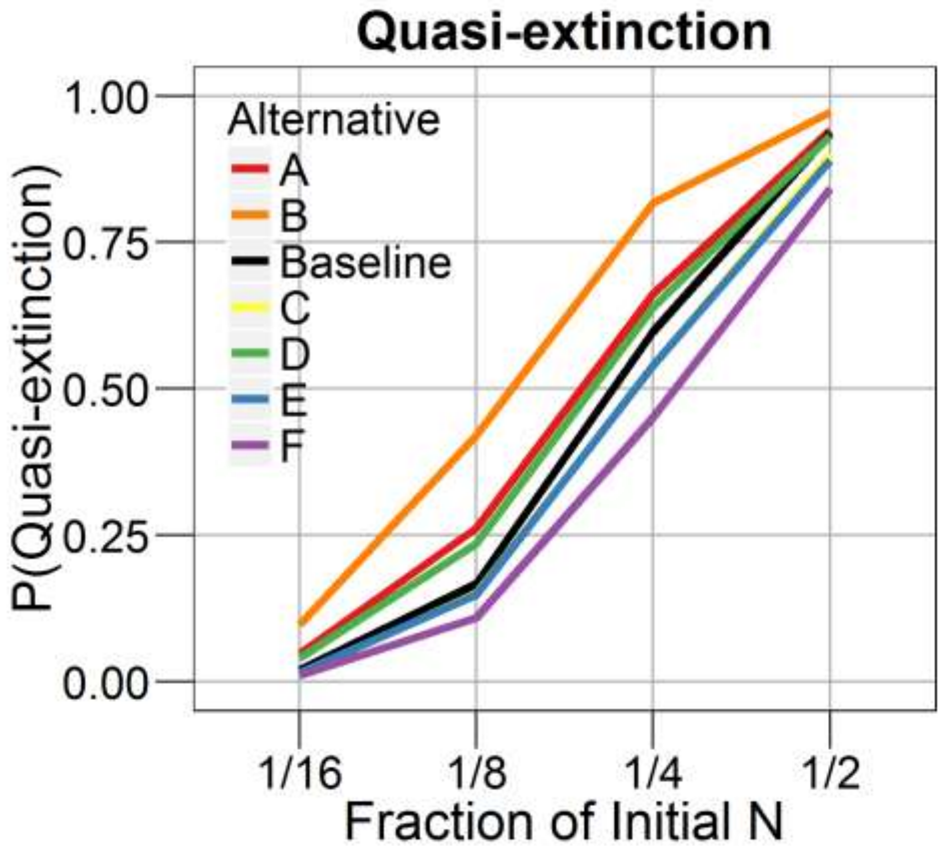


Figure 3. *Risk* analysis – DNR lands. Quasi-extinction probabilities (proportion of 10,000 simulations that reached a specified fraction of initial population size) for the primary proposed management alternatives (A – F).

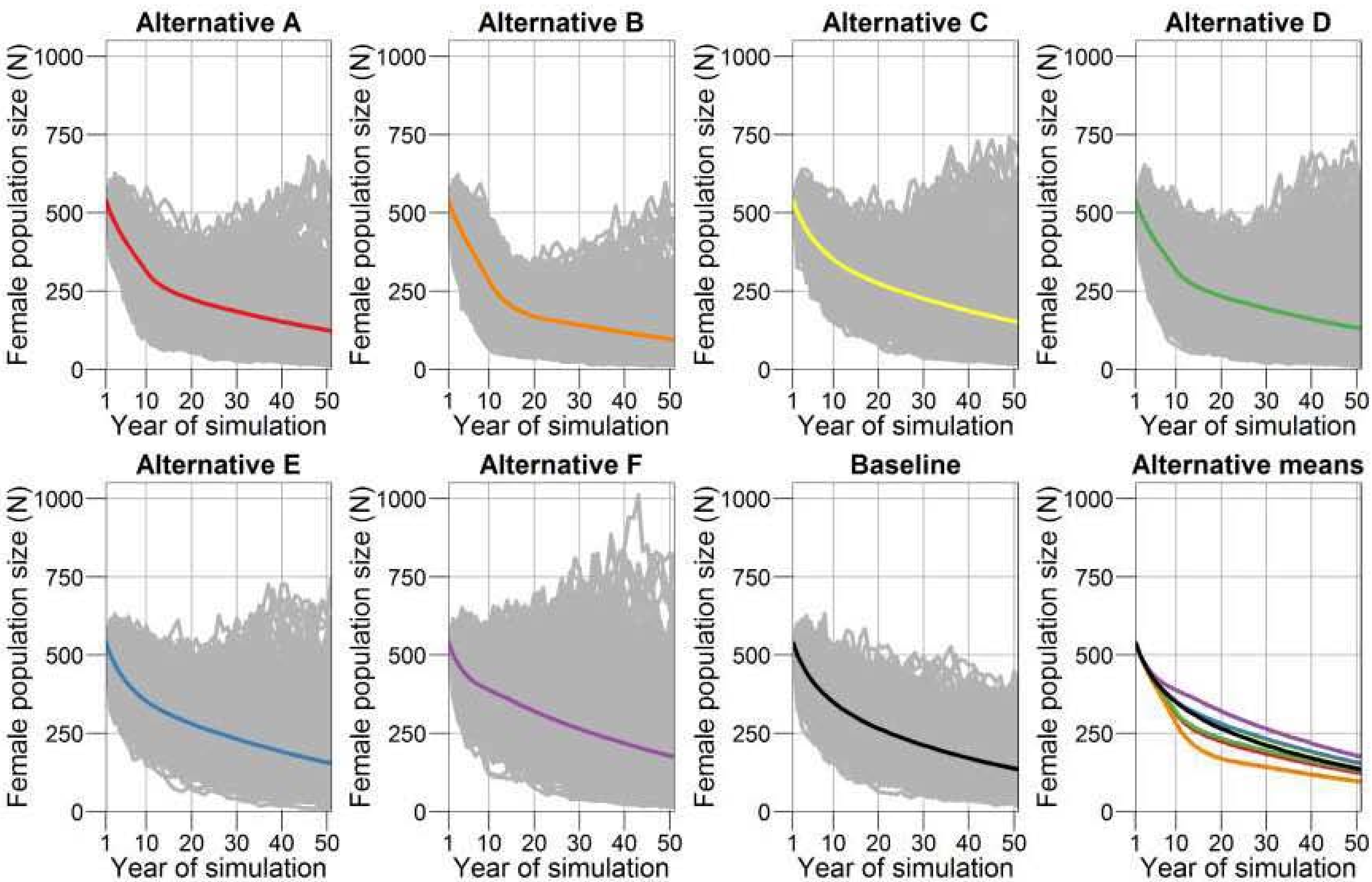


Figure 4. *Risk* analysis – DNR lands. Projected murrelet population sizes as a function of proposed management alternatives (A – F).

In each panel the colored line represents the mean annual population size averaged over 10,000 simulations, and the grey lines represent a subsample (n = 1,000) of individual simulation outcomes. The bottom-right panel ("Alternative means") plots the mean from each alternative on a single graph for the purposes of comparison.

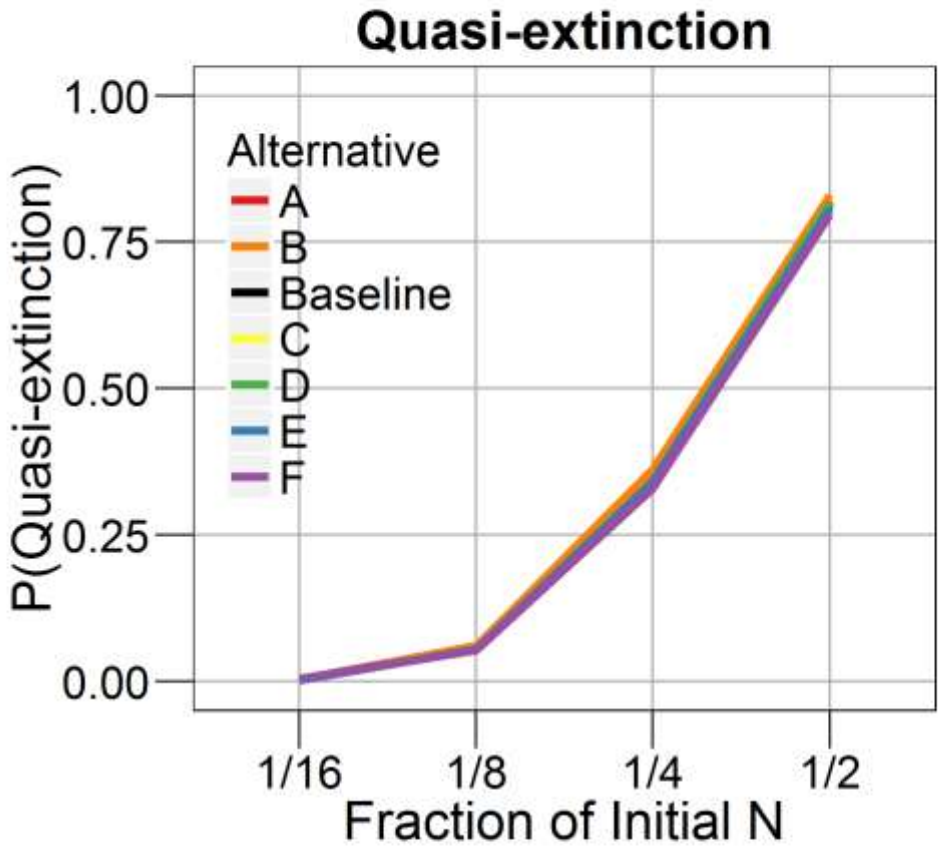


Figure 5. *Risk* analysis – Washington. Quasi-extinction probabilities (proportion of 10,000 simulations that reached a specified fraction of initial population size) for the primary proposed management alternatives (A – F).

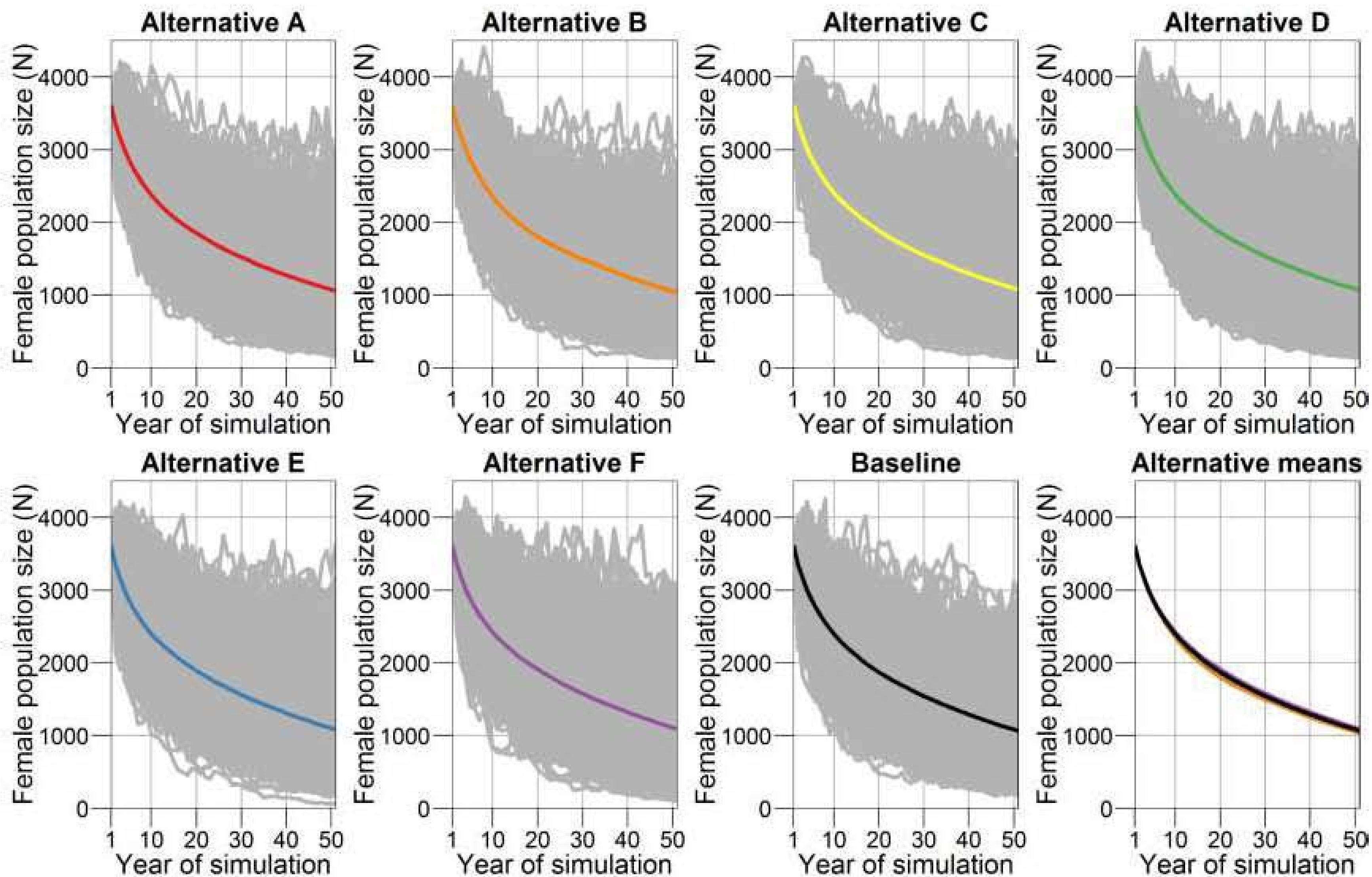

Alternative A
Alternative B
Alternative C
Alternative D
Alternative E
Alternative F
Baseline
Alternative means
Female population size (N)
0
1000
2000
3000
4000
1
10
20
30
40
50
Year of simulation

Figure 6. *Risk* analysis – Washington. Projected murrelet population sizes as a function of proposed management alternatives (A – F). In each panel the colored line represents the mean annual population size averaged over 10,000 simulations, and the grey lines represent a subsample (n = 1,000) of individual simulation outcomes. The bottom-right panel (“Alternative means”) plots the mean from each alternative on a single graph for the purposes of comparison.

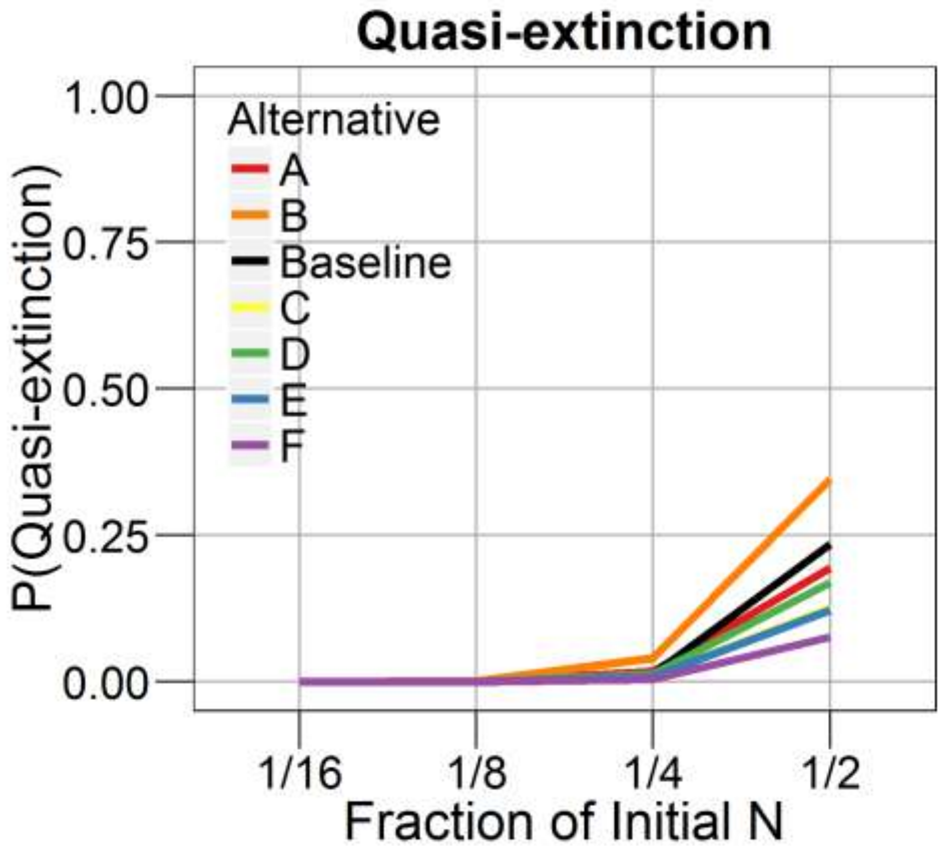


Figure 7. *Enhancement* analysis – DNR lands. Quasi-extinction probabilities (proportion of 10,000 simulations that reached a specified fraction of initial population size) for the primary proposed management alternatives (A – F).

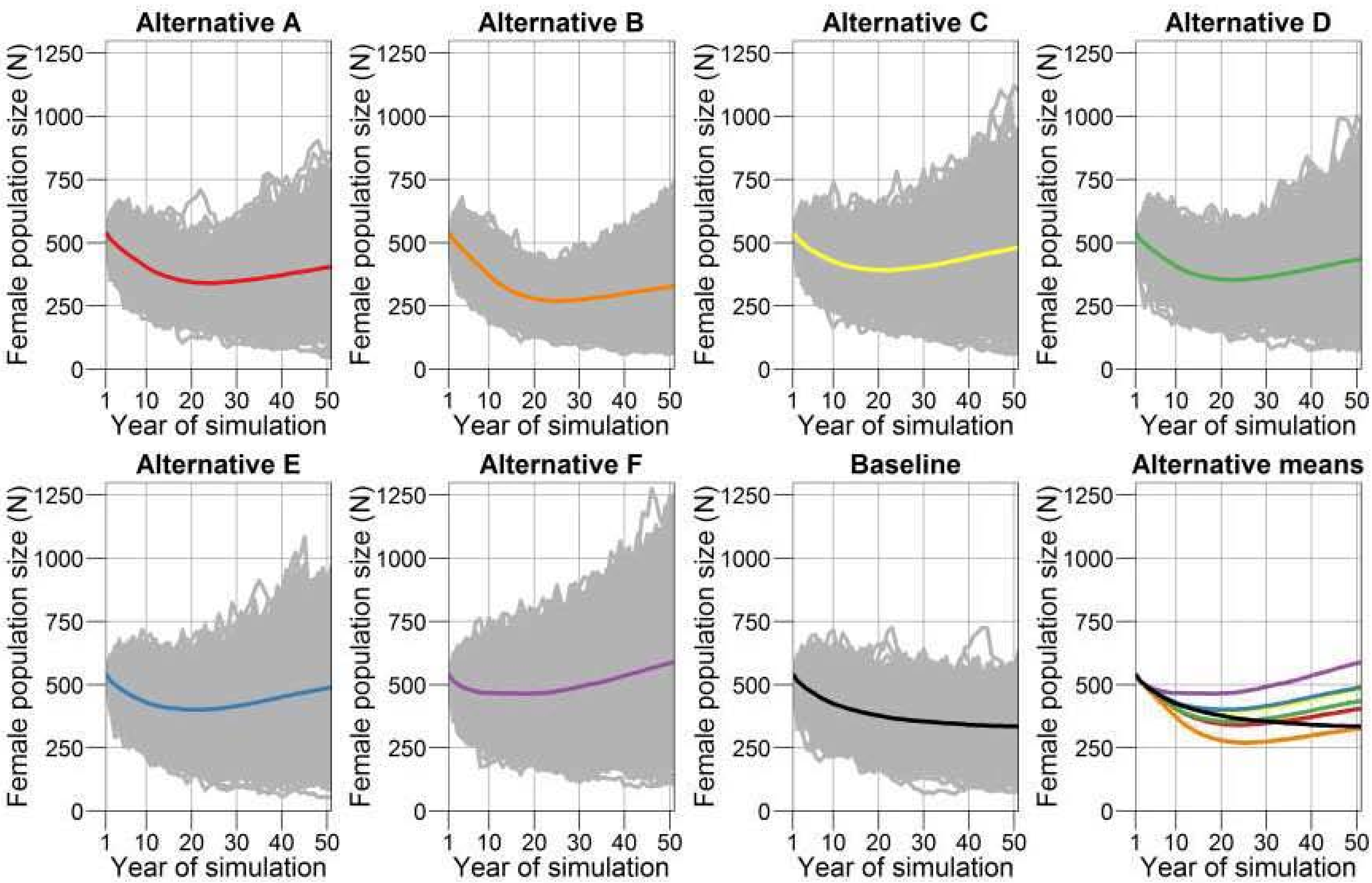

Alternative A
Alternative B
Alternative C
Alternative D
Alternative E
Alternative F
Baseline
Alternative means
Female population size (N)
0
250
500
750
1000
1250
Year of simulation
1
10
20
30
40
50

Figure 8. *Enhancement* analysis – DNR lands. Projected murrelet population sizes as a function of proposed management alternatives (A – F). In each panel the colored line represents the mean annual population size averaged over 10,000 simulations, and the grey lines represent a subsample (n = 1,000) of individual simulation outcomes. The bottom-right panel ("Alternative means") plots the mean from each alternative on a single graph for the purposes of comparison.

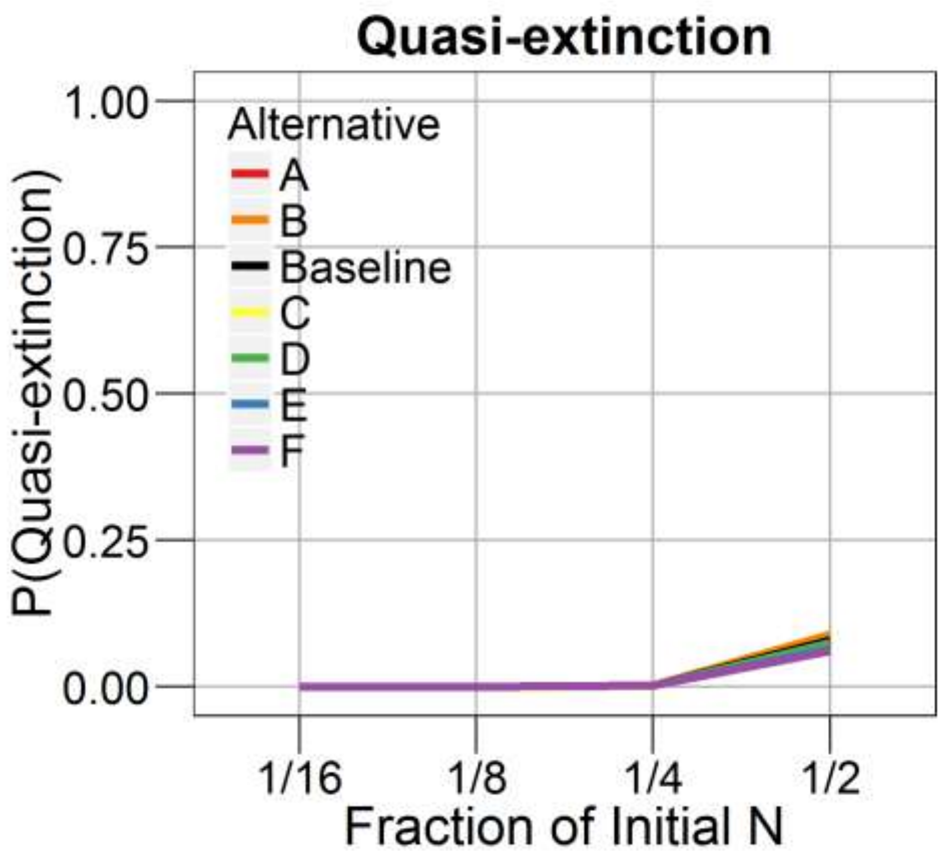
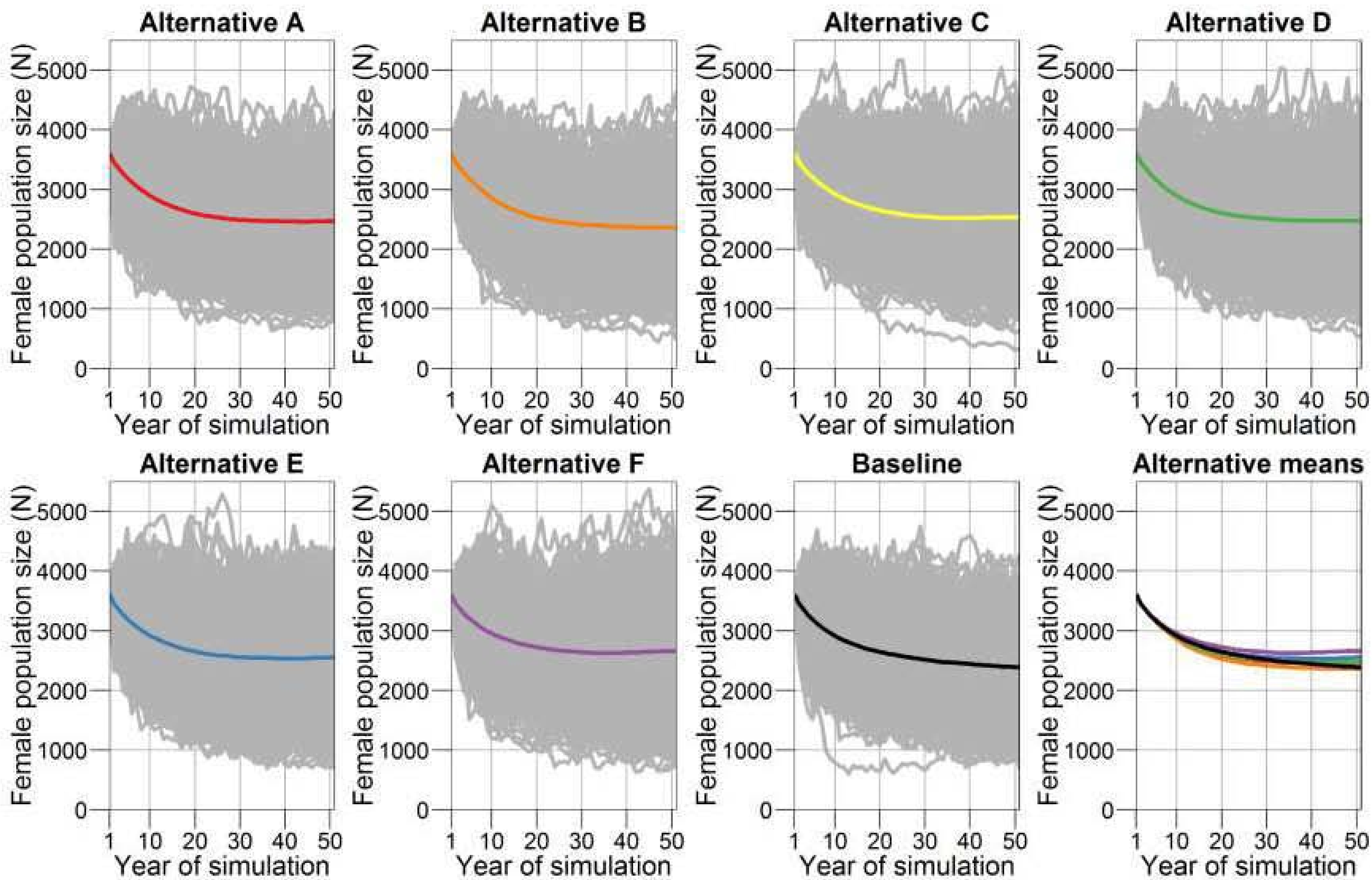


Figure 9. *Enhancement* analysis – Washington. Quasi-extinction probabilities (proportion of 10,000 simulations that reached a specified fraction of initial population size) for the primary proposed management alternatives (A – F).



Alternative A
Alternative B
Alternative C
Alternative D
Alternative E
Alternative F
Baseline
Alternative means
Female population size (N)
0
1000
2000
3000
4000
5000
Year of simulation
1
10
20
30
40
50

Figure 10. *Enhancement* analysis – Washington. Projected murrelet population sizes as a function of proposed management alternatives (A – F). In each panel the colored line represents the mean annual population size averaged over 10,000 simulations, and the grey lines represent a subsample (n = 1,000) of individual simulation outcomes. The bottom-right panel (“Alternative means”) plots the mean from each alternative on a single graph for the purposes of comparison.

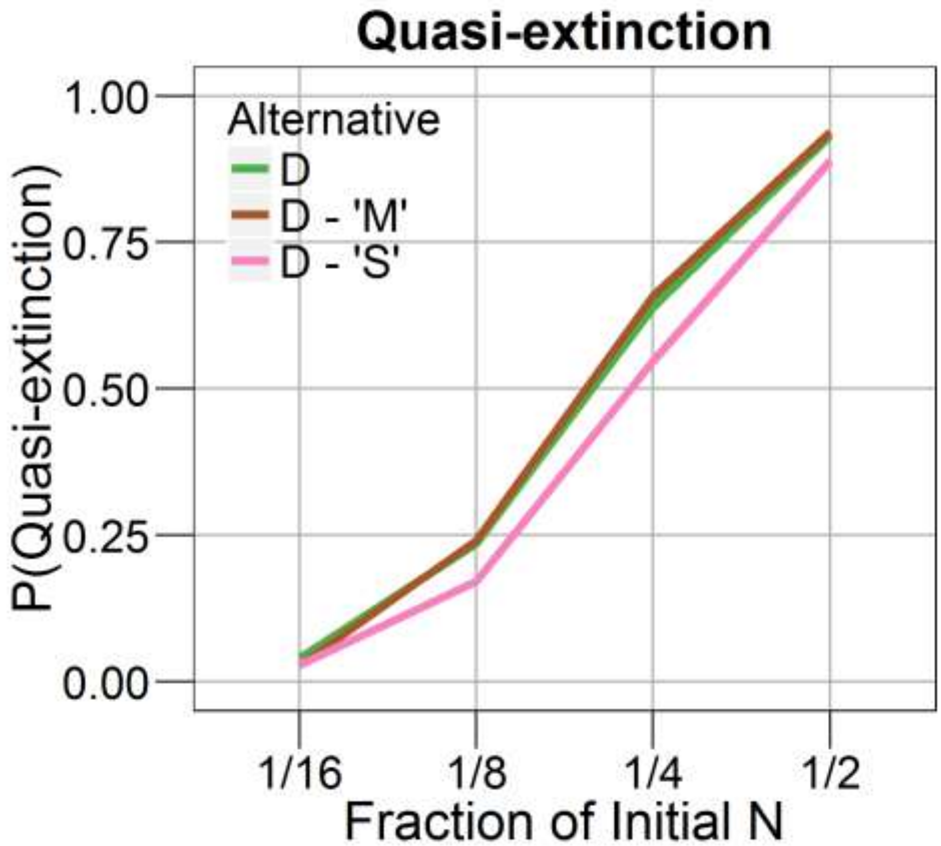


Figure 11. Exploratory *Risk* analysis – DNR lands. Quasi-extinction probabilities (proportion of 10,000 simulations that reached a specified fraction of initial population size) for alternative D compared to its two exploratory variants (D – 'M' and D – 'S').

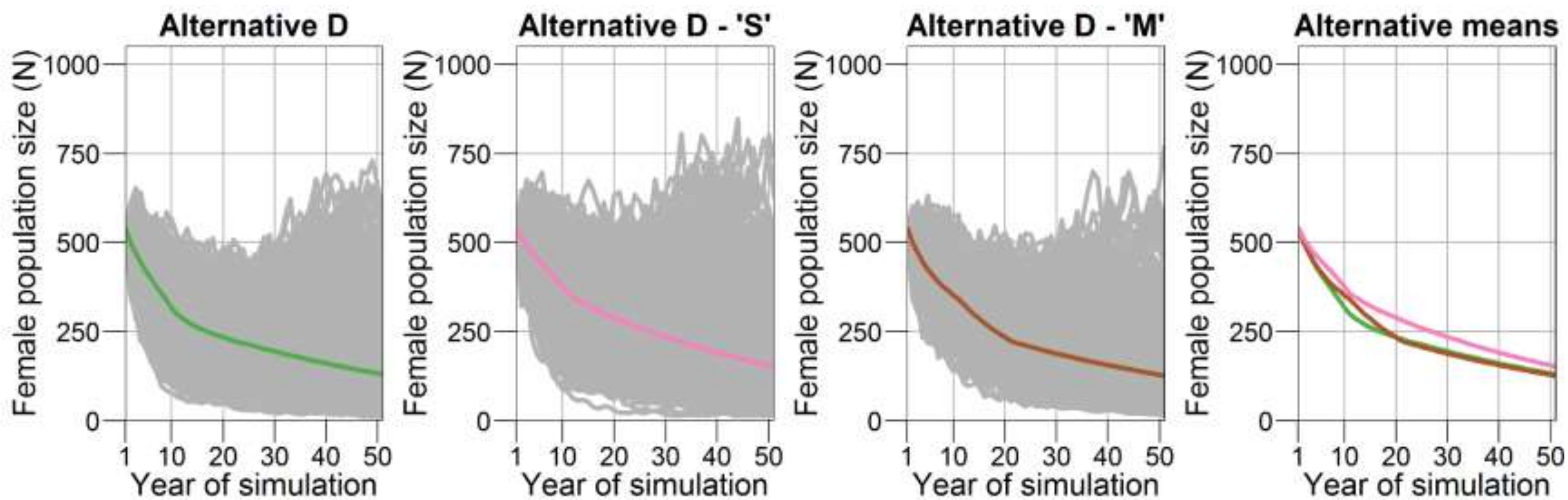


Figure 12. Exploratory *Risk* analysis – DNR lands. Projected murrelet population sizes as a function of alternative D compared to its two exploratory variants (D – ‘M’ and D – ‘S’). In each panel the colored line represents the mean annual population size averaged over 10,000 simulations, and the grey lines represent a subsample (n = 1,000) of individual simulation outcomes. The far-right panel (“Alternative means”) plots the mean from each alternative on a single graph for the purposes of comparison.

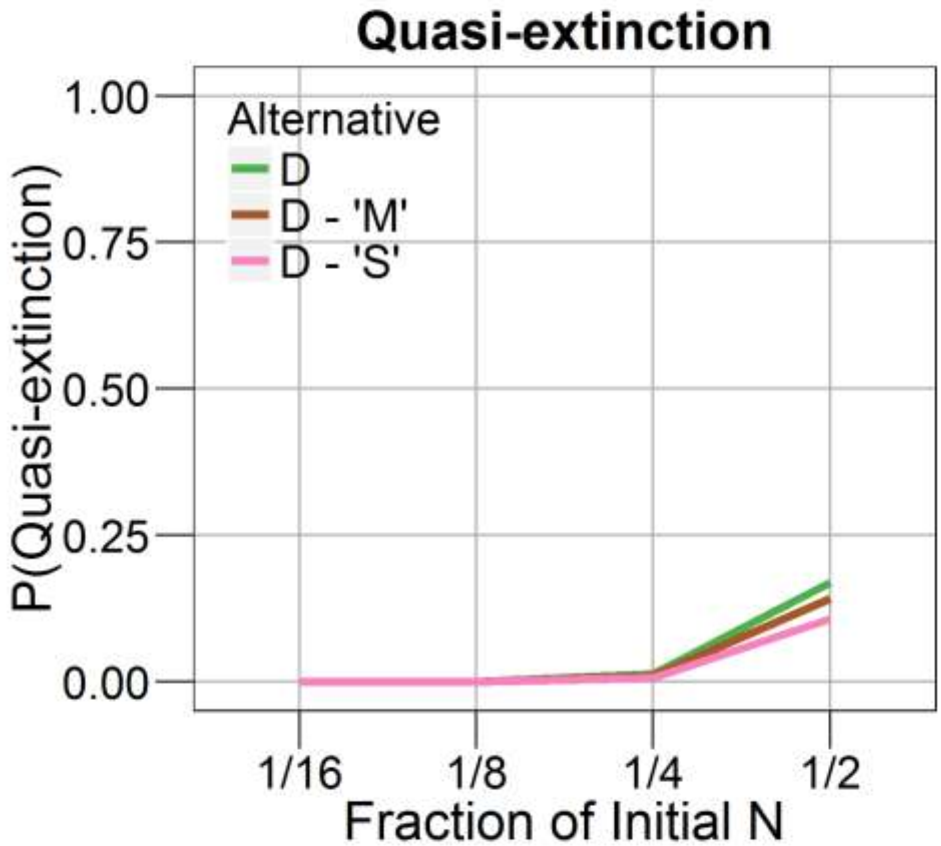


Figure 13. Exploratory *Enhancement* analysis – DNR lands. Quasi-extinction probabilities (proportion of 10,000 simulations that reached a specified fraction of initial population size) for alternative D compared to its two exploratory variants (D – 'M' and D – 'S').

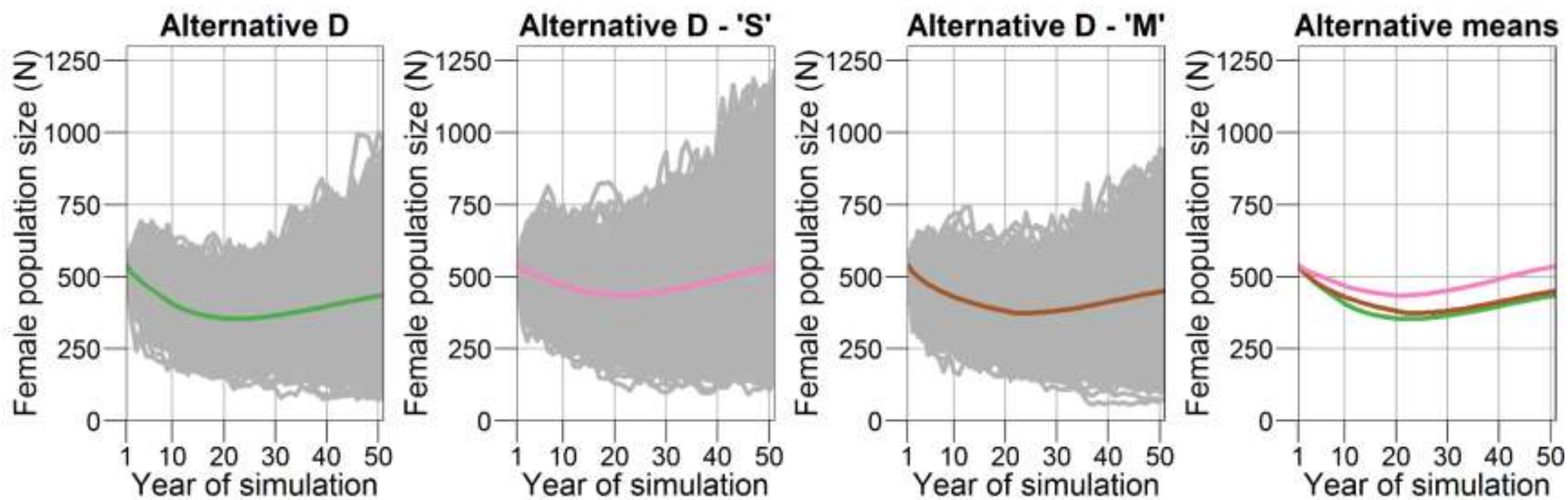


Figure 14. Exploratory *Enhancement* analysis – DNR lands. Projected murrelet population sizes as a function of alternative D compared to its two exploratory variants (D – ‘M’ and D – ‘S’). In each panel the colored line represents the mean annual population size averaged over 10,000 simulations, and the grey lines represent a subsample (n = 1,000) of individual simulation outcomes. The far-right panel (“Alternative means”) plots the mean from each alternative on a single graph for the purposes of comparison.

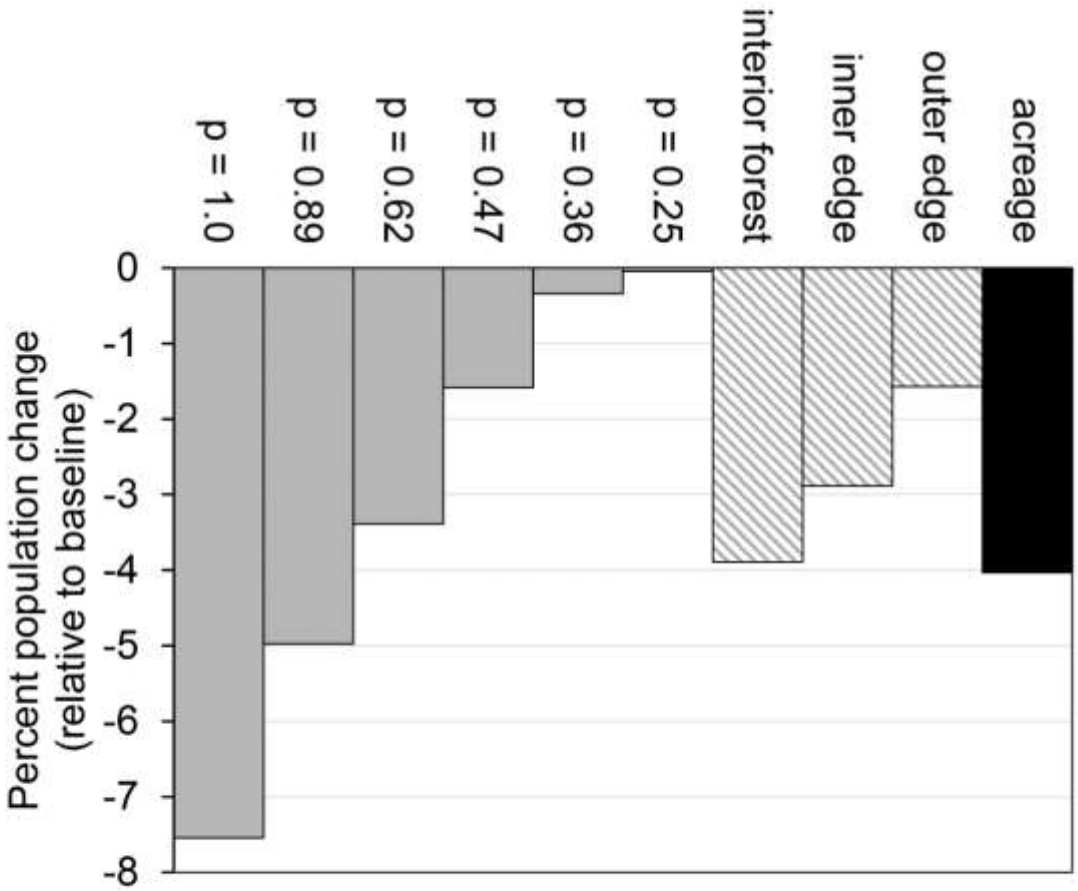


Figure 15. Sensitivity analysis. Grey solid bars represent habitat quality (Pstage), grey hatch-marked bars represent habitat configuration (edge conditions), and the black bar represents habitat amount (raw acreage).

Appendix

Nest Density – Based on the assumptions that a threshold acreage of habitat is required to provide one nest site and that nesting habitat is limited so that there is just enough for the current statewide population, i.e, the population is at the carrying capacity, *K*, of its forest habitat. WA state habitat estimates are from Raphael et al. (2016) and the murrelet population is estimated as the average WA at-sea population over the latest 5 years of monitoring, 2011-2015 (Falxa et al. *in press*). Habitat quality, and consequently the availability of potential nest sites, is assumed to be influenced by stand condition, edge effects including lack of habitat capability in strings, and geography (see below). Adjusted acreages for non-DNR land are based on Science Team (Raphael et al. 2008) assumptions for habitat quality and accessory assumptions for edge conditions and strings (i.e., assume federal habitat consists of half as much edge and strings while private habitat consists of 50% more edge and strings than DNR-managed land). Adjusted acreages for DNR land are based on assumptions regarding the influence of stand development, edge effects, and geography on habitat quality (see below) applied to estimated habitat acreage (Raphael et al. 2016). Nest density, *D*, is estimated as the total number of murrelets in WA divided by the total adjusted habitat acreage, *A*.

Raw Habitat (DNR) – Acreage of habitat (*Pstage*>0) symbolized as *H*, based on interpretation and projection of DNR's spatially-explicit forest inventory. This estimate of current habitat (*Pstage*>0), 213,400 acres, differs slightly from that of Raphael et al. (2016) which was used to estimate Nest Density, 187,100 acres.

Adjustment for Habitat Quality (DNR) – This incorporates three influences on habitat quality as it relates to function in providing nesting opportunities and *K*: stand condition, edge effects, and geography. DNR's spatially-explicit forest inventory summarizes acreage (*H*), composition, and structure for stands, contiguous forest patches with sufficiently uniform composition and structure to be distinguishable units. Each stand has a current and projected future *Pstage* value (0, 0.25, 0.36, 0.47, 0.62, 0.89, 1) which reflects habitat quality, thus its capacity to provide nest sites as *H* * *Pstage*. Edge effects, *E*, are influenced by two factors, distance from edge and edge type as summarized in the table below. Edge type and distance were estimated with spatial analyses of DNR forest inventory and the proposed conservation alternatives. Geographic influence, *G*, was incorporated by mapping habitat over 5 km from the nearest occupied murrelet site where the diminished attractiveness and/or availability of nest sites was assumed to have a further effect, 0.25, on habitat quality at these isolated habitat patches. Less than 5% of DNR-managed habitat, *H*, is so isolated, thus *G* = 1 for the large majority of habitat.

		Interior (*t*)	Inner Edge (r)	Outer Edge(*o*)	String
Edge Type	None (*n*)	1	1	1	0
	Soft (*s*)	1	0.8	0.6	0
	Hard (*h*)	1	0.625	0.25	0

Stands of current and projected future habitat (*Pstage*>0) were spatially partitioned by multiple factors important to DNR forest management including edge distance and geography (approximately 1,000,000 partitions varying by time-step and alternative), so that each partition, *i*, had an unique acreage H_i, and was in one of twenty-four *Pstage*/Edge-distance categories. Habitat was configured either in small, often fairly linear fragments called *strings* that contained no interior forest, or in larger blocks that contained habitat in outer (*o*) and inner (*n*) edges as well as in interior forest (*t*), >100 meters from edge. Edge effects were assumed to negate the value of habitat in strings. Depending on alternative, 16% - 34% of habitat was in strings. Edge effects on inner and outer edge habitat was estimated with non-spatial methods based on the assumption that current proportions of edge types on conservation lands, averaged across their alternative designations approximate the long-term proportion of edge types due to the balance of growth and harvest across the land base. Thus, current and projected future edge effects to inner and outer edge forests were distributed across edge types according to the average proportions of no (p_n = 0.422), soft (p_s = 0.307), and hard (p_h = 0.271) edge.

Six of the eighteen, non-string *Pstage*/Edge-distance categories are interior (t) and not subject to edge effects. The habitat quality adjustments described above were applied to all j spatial partitions within the interior categories and estimate the "functional capability" of murrelet habitat over 100 meters from potential edge as the sum of adjusted habitat acreage:

$$A_t = \sum_{i=1}^{j} H_i * Pstage_i * G_i * E_t$$

where $E_t = 1$. The adjusted habitat acreage within inner and outer edge categories are calculated as:

$$A_r = \sum_{i=1}^{j} H_i * Pstage_i * G_i * ((E_{nr} * p_n) + (E_{sr} * p_s) + (E_{hr} * p_h))$$

and

$$A_o = \sum_{i=1}^{j} H_i * Pstage_i * G_i * ((E_{no} * p_n) + (E_{so} * p_s) + (E_{ho} * p_h)),$$

respectively. The sum of adjusted acreages in interior and the two edge categories estimates A_{DNR},

$$A_{DNR} = A_t + A_r + A_o.$$

K (DNR) – The estimated number of nest sites on DNR-managed land, calculated as $K_{DNR} = D * A_{DNR} * 0.5$ to reflect a population that is half female.

Nest Success (DNR) – Based on the assumption that edge effects are a primary influence on nest success, f. High nest success, f_{high} is assumed to be 0.55 and low success, f_{low}, 0.38 (McShane et al. 2004), with intermediate success, f_{int}, halfway between. Edge effects are influenced by two factors, distance from edge and edge type as summarized in the table below (Malt and Lank 2009). Edge type and distance from edge were estimated with spatial analysis of DNR forest inventory.

		Interior	Inner Edge	Outer
Edge Type	None (*n*)	0.55	0.55	0.55
	Soft (*s*)	0.55	0.55	0.55
	Hard (*h*)	0.55	0.465	0.38

Similar to adjustments for habitat quality, nest success was estimated by a combination of spatial and non-spatial analyses. Seven of the nine Edge-distance/Edge-type categories are interior or influenced by no or soft edge and are not subject to edge effects. Their influence on nest success, f, was estimated for all j spatial partitions within those categories as

$$f_{t,n,s} = \sum_{i=1}^{j} H_i * f_{high}$$

The influence of inner and outer hard edges on nest success was estimated as

$$f_{hr} = \sum_{i=1}^{j} H_i * f_{int}$$

and

$$f_{ho} = \sum_{i=1}^{j} H_i * f_{low}$$

thus

$$f_{DNR} = f_{t,n,s} + f_{hr} + f_{ho}$$

Raw Habitat (Other) – Estimates from Raphael et al. (2016).

Adjustment Factor (Other) – Based on the same logic and edge effects described for the DNR adjustment factor but using Science Team (Raphael et al. 2008) assumptions for habitat quality and the assumptions for edge conditions and strings summarized above, i.e., federal habitat consists of half as much edge and strings while private habitat consists of 50% more edge and strings than DNR-managed land.

K (Other) – The estimated number of nest sites on federal and other non-federal land, calculated as described above.

Nest Success (Other) – Estimated as above, based on the assumptions about edge on non-DNR lands (federal habitat consists of half as much edge while private habitat consists of 50% more edge than DNR-managed land).

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Appendix D. Occupied Sites Focus Paper

Occupied Sites | Focus Paper #4

This focus paper was part of a series presented to the Board of Natural Resources in October and November 2015 to inform development of the marbled murrelet long-term conservation strategy alternatives. The purpose of this focus paper is to describe the scientific methods used to identify sites occupied by marbled murrelets (occupied sites) for purposes of protecting these sites under the long-term strategy.

What are occupied sites?

Occupied sites represent the best information we have about where murrelets might be nesting. They are forested areas where evidence of either murrelet nests, eggs, or chicks have been found or where murrelet nesting behaviors have been observed.

Murrelet nests are difficult to find. A set of criteria is used in the field to determine if a forest stand is likely to be used by murrelets for nesting (see box). Certain behaviors, which have been documented at active nest sites, are used during audio-visual survey as indicators of occupancy.[1] These behaviors have also been associated with purposes other than attending an active nest, suggesting that the stand has some importance for breeding.

Because of the difficulty in finding the specific tree within a forest stand that a marbled murrelet might be using as a nest tree, most occupied sites are determined through observation

Occupied sites are contiguous areas of habitat where at least one of the following occurs:

1. **A murrelet nest is located**
2. **Downy murrelet chicks or eggs or egg shell fragments are found**
3. **Marbled murrelets are detected flying below, through into or out of the forest canopy**
4. **Marbled murrelets are heard calling from a stationary location within habitat**
5. **Marbled murrelets are seen circling above a stand within one tree height of the top of the canopy.**

[1] Only trained, certified murrelet surveyors are qualified to identify murrelet nesting evidence and behaviors.

of marbled murrelets flying below, through or into or out of the forest canopy, and/or marbled murrelets circling above a forest stand within one tree height of the top of the canopy. This type of observation is documented as an "occupied detection." A majority of the occupied sites mapped on DNR lands were identified through occupied detections. [2] Few occupied sites have been documented by finding the actual nest, murrelet chicks or egg shell fragments, or by calling from a stationary location. Nest sites are confirmed only when an actual nest is identified in a tree platform. Out of the 5,202 occupied detections in Washington State, only 51 are associated with confirmed nests; of those, 13 are on DNR-managed lands.

How are occupied sites delineated for purposes of conservation planning?

At the signing of DNR's Habitat Conservation Plan (HCP) in 1997, few occupied sites had been identified and little was known about murrelet nesting habitat in Washington State, including on DNR-managed lands. In granting DNR an Incidental Take Permit for marbled murrelets, the U.S. Fish and Wildlife Service (USFWS) agreed to an interim marbled murrelet conservation strategy to gather knowledge about marbled murrelet habitat needs before developing a long-term habitat conservation strategy. Part of this interim strategy included a habitat relationship study and an intensive survey program of potential nesting habitat (HCP 1997). DNR's survey program had begun in 1994, anticipating the need for information about marbled murrelet occupancy for the development of an HCP. As a result of the HCP survey effort, 401 occupied sites, totaling approximately 45,000 acres, were identified on DNR-managed lands. These occupied sites range in size from under 5 acres to 3,100 acres, and are between 0 and 53 miles from marine waters.

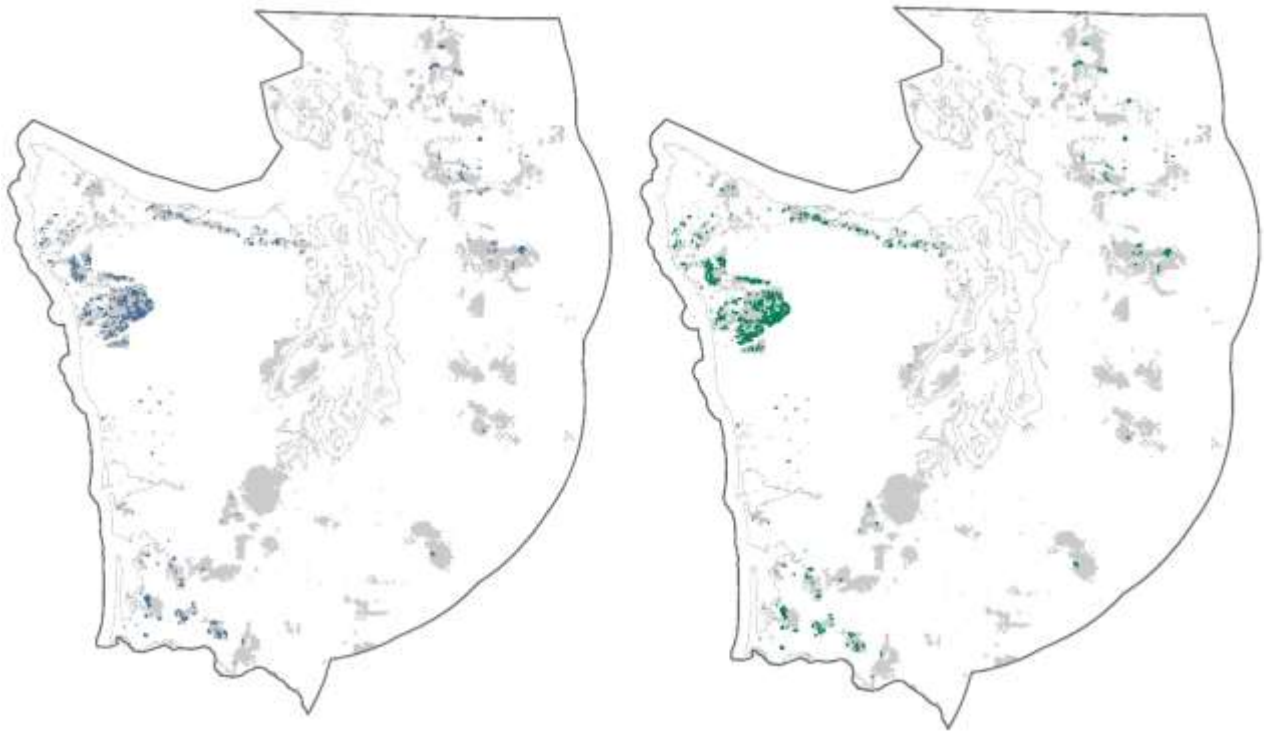
Occupied sites identified within the Straits, OESF, South Coast and Columbia HCP planning units were reviewed and adjusted by a "Science Team" put together in 2004 by DNR to develop recommendations for marbled murrelet conservation (Raphael and others 2008). The Science Team recommended increasing the total occupied site acres on DNR managed lands to approximately 61,000 acres; this was an increase of approximately 16,000 acres over what was delineated as occupied under the HCP, based on the initial survey effort. Occupied sites in the North and South Puget HCP planning units were delineated by DNR staff in the field based on platform-bearing trees or through the inspection of color orthophotos.

For purposes of conservation planning, there are therefore two "sets" of occupied sites to consider. The initial set of occupied sites (approximately 45,000 acres) are those delineated under the HCP survey effort. The second iteration of occupied sites (approximately 61,000 acres) incorporates the work of the Science Team.

[2] The Washington Department of Fish and Wildlife maintains a database of occupied detections.

Figure 1. Mapped Occupied Sites on DNR-Managed Lands:

a) **HCP survey sites** b) **Science Team delineated sites**



How did DNR select habitat to survey?

The interim habitat conservation strategy focused the department's survey efforts on marbled murrelet habitat known as "reclassified habitat;" see Attachment 1 for a stepwise explanation of how this habitat was defined.

"Reclassified habitat" is a term to describe high quality marbled murrelet habitat identified by predictive models. This habitat was expected to contain 95% of the occupied sites found in surveys.

Briefly, reclassified habitat was identified through the use of a habitat relationship study predictive model (Prenzlow Escene 1999). Two classes of habitat were identified based on this model:

1. **Marginal habitat**: defined as those lands expected to contain a maximum of five percent of the occupied sites on DNR-managed lands within each planning unit. These areas were made available for harvest. All known occupied sites were deferred from harvest and were not included in this habitat designation. Harvest of marginal habitat is permitted under the interim strategy incidental take permit.

2. **Higher-quality habitat:** defined as those lands expected to contain at least 95% of the occupied sites on DNR-managed lands within each planning unit. This habitat is frequently referred to as "reclassified habitat."

The interim strategy directed DNR to survey all reclassified habitat acres using survey protocols developed by the Pacific Seabird Group. Based on the observations made at each survey site, each location within reclassified habitat would be determined to be "occupied" or "surveyed, unoccupied." Survey results were then submitted to Washington State Department of Fish and Wildlife (WDFW), which is charged with stewarding all marbled murrelet survey data.[3]

How did DNR conduct surveys?

Marbled murrelet surveys to identify occupied sites were conducted in each HCP planning unit between the period of 1994 and 2009. Surveys were conducted according to inland survey protocols developed and updated by the Pacific Seabird Group (PSG), Marbled Murrelet Technical Committee, or other methods approved by USFWS.[4] These protocols were updated over time, with DNR using the most current protocol. Most surveys were conducted for two years (usually 5 visits per year) or until murrelets were observed flying within the forest canopy (i.e., occupied behavior); whichever was sooner. The layout of survey sites and stations was planned by DNR staff using aerial photography and GIS mapping techniques. Field-location of survey stations, and the actual murrelet surveys were conducted by several private consulting firms (Resources Northwest, Inc.; Hamer Environmental; and Turnstone Environmental Consultants, Inc.) with substantial review by the contractor and DNR staff.

Survey results are summarized in Table 1, with explanations for each planning unit provided below.

Results

DNR completed marbled murrelet surveys for the South Coast and Columbia planning units in 2002 and for the Straits planning unit in 2003. The OESF inventory surveys were almost (80%) complete in 2002 and were discontinued because DNR requested to USFWS that it was reasonable to enter into the long-term planning process with the understanding that a multi-agency science team could adequately develop a conservation strategy without completing the surveys (DNR –USFWS 2003). The 2008 Science Team Report considered unsurveyed acres in the broader context of its landscape scale recommendations. The surveys were targeted to reclassified habitat identified through the habitat relationship studies for these

[3] Authority is granted to WDFW under WAC 222-16-010 *General definitions. "In determining the existence, location and status of occupied marbled murrelet sites, the department shall consult with the department of fish and wildlife and use only those sites documented in substantial compliance with guidelines or protocols and quality control methods established by and available from the department of fish and wildlife."

[4] Pacific Seabird Group survey protocols from Ralphael and others (1994, 1995b, 1996, 1997, 1998) and Evans Mack et al., (2000, 2003). Sampling design approved by DNR and USFWS was used for habitat in the Natural Resource Conservation Areas and Natural Area Preserves.

planning units. Habitat was identified through an alternative process in North and South Puget Planning units (see below) beginning in 2007. Results are summarized in Table 1.

Table 1. Survey Results Summary by Planning Unit

Planning Unit	Results				
	Approximate Acres of Habitat Identified[a]	Approximate Surveyed Acres	Occupied Sites (in Acres) HCP Occupied Site Acres	Occupied Sites (in Acres) Science Team Delineated Occupied Site Acres	Unsurveyed Acres
OESF	54,500	39,500	25,882[b]	39,611	15,000
Straits	15,600	15,600	3,942	5,661	0
South Coast and Columbia	27,000	27,000	8,741	9,656	0
North Puget	30,000 *Note: "Suitable and potential habitat"*	17,500	5,583	5,583	[c]
South Puget[d]	674 *Note: "Suitable habitat"*	575	575	575	[e]

[a] Acres of high quality habitat were adjusted by the Science Team based on a review of the survey results and habitat relationship studies.

[b] Total occupied sites include those sites also identified by surveys conducted by the Washington Department of Fish and Wildlife in 2001-2002 in response to the Tenyo Maru oil spill disaster. Protocols for the surveys conducted by WDFW are described in http://www.darrp.noaa.gov/northwest/tenyo/pdf/ten-mmfnl0203.pdf.

[c] As of February 2014, in the North Puget Planning Unit, 4,300 acres of identified "suitable habitat" remained unsurveyed. Also, there remained 17,300 acres of "potential habitat" that needed to be field verified and classified as suitable habitat or unsuitable habitat. Based on previous field inspections of potential habitat, it is estimated 30-50% of potential habitat in NPPU could be identified as suitable habitat.

[d] All surveys in the South Puget planning unit were conducted with radar.

[e] There are 2,131 "potential habitat" acres identified through a methodology agreed to by USFWS and DNR (see below).

North Puget HCP Planning Unit

In the case of the North Puget planning unit (NPPU), the reclassified habitat model did not perform well due to the low number of occupied sites found in the habitat relationship study. Higher quality marbled murrelet habitat was discovered scattered throughout areas in the planning unit. These pockets of higher quality habitat were not identified by the reclassified habitat model, and thus were not scheduled to be surveyed. USFWS and DNR agreed to a different approach to identifying habitat for the surveys (known as "reclassified plus"). A detailed reporting of this habitat selection for survey can be found in the "Final NPPU Marbled Murrelet Concurrence Letter," dated February 23, 2007.

Briefly, all areas identified by various data sources (reclassified modeling efforts, local knowledge, and professional judgment) were mapped as "potential habitat." These potential habitat areas were field checked to meet the HCP definition of suitable habitat (stands containing on average at least of two, 7-inch platforms per acre, greater or equal to five-acre patches, within 50 miles of marine water).[5] If these criteria were found on site, then the stand was scheduled for survey. Additionally, any new areas found to meet the suitable habitat definition outside mapped potential habitat were not scheduled for survey, but were deferred for consideration under the long-term conservation planning process. A total of 71 occupied sites[6]were delineated through these survey efforts (see Table 1).[7]

South Puget HCP Planning Unit

The South Puget HCP planning unit (SPPU) is unique within the DNR's HCP planning units. Although it is within the breeding range of the marbled murrelet, the adjacent offshore population of murrelets is extremely low. Low population numbers and limited suitable habitat within the planning unit indicate that the probability of inland detections of murrelets is very low. This suspicion is corroborated by the fact that murrelet detections on non-DNR lands adjacent to the SPPU have been low. Without an adequate number of inland detections, the habitat relationship study outlined in the HCP is not appropriate. In lieu of the habitat relationship study, the DNR and USFWS developed an alternate methodology to identify potential murrelet habitat in the SPPU. This alternate methodology applies known features of murrelet habitat to existing forest inventory data to develop models and screening tools that identify areas of potential murrelet habitat. This alternate methodology also incorporates local and historical knowledge of known habitat areas. A detailed reporting of this habitat selection for survey can be found in the "Final SPPU Murrelet Habitat Identification Concurrence Letter," dated July 16, 2009. Potential habitat was selected from the following sources:

- DNR's Weighted Old Growth Habitat Index

[5] HCP Chapter IV, pages 40-42.
[6] The number of occupied sites is based on how they are delineated in DNR's GIS as of the date of this paper.
[7] "Suitable habitat acres" is subject to change due to ongoing field work related to timber sales.

- DNR's Forest Resources Inventory System (FRIS) Age Data
- Low level aerial surveys (Burger 2004)
- Forest Practices Board Manual Inventory Model Method for identifying marbled murrelet habitat
- Local knowledge and professional judgment.

As in the NPPU, these potential habitat areas were to be field checked to meet the HCP definition of suitable habitat under the interim strategy (see above, and Attachment). Surveys of suitable habitat have not been conducted in the SPPU due to difficulty identifying habitat. However, a one-time pilot project using radar surveys was initiated in 2007 with the attempt to document murrelet presence within the planning unit. This project and subsequent suitable habitat mapping identify five individual sites in South Puget, totaling approximately 575 acres (see footnote #6).

Does DNR still survey?

DNR is not currently conducting analysis area-wide surveys. In the North Puget planning unit, DNR continues to conduct some site-specific surveys related to timber sales. New occupied site boundaries are determined by DNR and USFWS on a case-by-case basis, in consultation with the Washington Department of Fish and Wildlife.

How accurate are occupied site delineations?

There are two primary areas of uncertainty related to accurately identifying occupied sites. First, there is uncertainty with the accuracy of modeling high quality (reclassified) habitat, where inventory surveys were targeted. The Science Team addressed this by comparing color orthophotos and using limited field verification, resulting in re-delineation of habitat as necessary (adding approximately 16,000 acres). As described above, uncertainties with the modeling efforts in North Puget resulted in occupied sites being field-delineated in that planning unit.

Second, there is some uncertainty built into the application of survey protocols. The protocols were revised annually by PSG throughout and after the DNR surveys were conducted; earlier surveys were not necessarily consistent with the most current protocols. The 2003 PSG survey protocols, which came out after DNR surveys under the interim strategy were concluded, recommended that surveys take place over two consecutive years, because murrelets may occupy a site one year and not the next. The revised protocol recommended a change from a minimum of four site visits to five visits per year. Based on the 2003 protocol, the Science Team evaluated the older DNR surveys and estimated potential error rates, making adjustments to recommended habitat conservation as necessary (see Appendix F of Raphael and others 2008 for detailed description).

How does the long-term conservation strategy address occupied sites?

Occupied site data are a key component of the habitat classification model being used under the analytical framework for the long-term marbled murrelet long-term conservation strategy (see Focus Paper #3, "Estimating the Location and Quality of Stands of Marbled Murrelet Habitat"). For purposes of the long-term conservation strategy, all survey-verified occupied sites are valued as high quality habitat.

Occupied sites are variable; the structure, availability, and complexity of habitat varies across DNR-managed lands within the range of the marbled murrelet, and the birds appear to use a range of habitat quality. For example, although the occupied sites were located in the high quality (reclassified) habitat in OESF, even the marginal habitat in the OESF planning unit was of relatively higher quality compared to habitat in other planning units. The Straits planning unit includes occupied sites with little or no structure, perhaps because of a large, adjacent marine population of birds.

DNR has analyzed known occupied sites based on their size, number and type of detections, and forest structure in order to rank these sites based on quality. All of the conservation approaches being developed for the long-term strategy protect occupied sites, but with different strategies. Some conservation alternatives protect strategically located sites or groups of sites within larger habitat areas that include buffers and/or security forests. Other alternatives focus conservation on the occupied sites as currently mapped. All of the alternatives propose to include lands beyond occupied sites that provide marbled murrelet habitat value (see Focus Paper #2, "Areas of Long-Term Forest Cover").

Attachment 1:

The Reclassified Model under the Interim Strategy

The interim marbled murrelet strategy in the 1997 State Trust Lands HCP provides five steps to guide the DNR in protecting the marbled murrelet on DNR-managed trust lands in the area covered by the HCP, while participating in collection of the information needed to develop a long-term conservation strategy. DNR relied upon these steps to develop a "model" that predicts murrelet occupancy at the stand level. The information below describes these steps that will assist DNR in developing the long-term conservation strategy.

1. Defer suitable habitat blocks

During development of the interim strategy in 1997, the Joint Agencies agreed to a conservative definition of suitable habitat, prior to developing the DNR predictive model. The conservative nature of the suitable habitat definition was intended to ensure DNR avoided "take" of habitat prior to the completion of predictive model. Once the predictive model was developed, it reclassified the definition of habitat from suitable habitat to "Reclassified Habitat and Marginal Habitat."

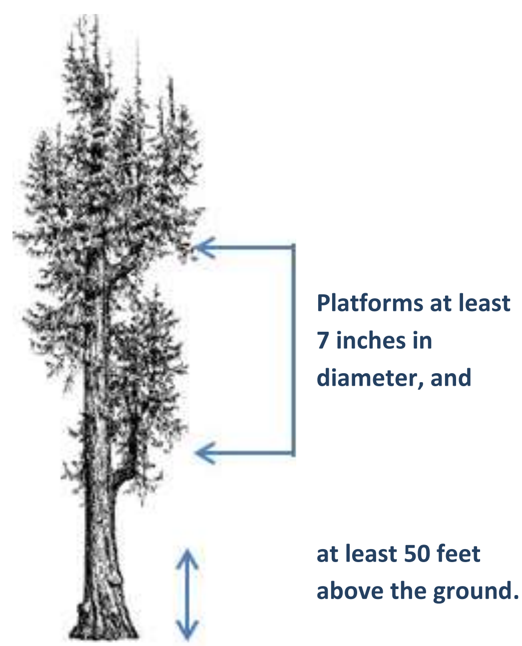
Interim strategy suitable habitat definition

A contiguous forested area meeting all of the three criteria:

- At least five acres in size
- Containing an average of at least two potential nesting platforms per acre and
- Within 50 miles of marine waters.

Potential nesting platforms

For the interim strategy, suitable platforms were considered to be a large limb or other structure at least 50 feet above ground and at least 7 inches in diameter.



2. Conduct habitat relationship studies

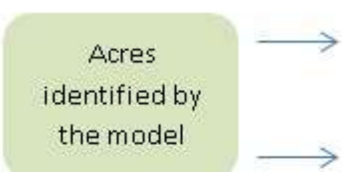
In 1994, DNR initiated Habitat Relationship Studies in each planning unit to collect forest data from 54 plots located in stands with a range of habitat quality characteristics. DNR surveyed each of these plots to determine which were occupied.

Finally, DNR compared the data collected and the occupancy status to evaluate which data might predict occupancy. Based on these studies, DNR developed new criteria to predict occupancy (Prenzlow-Escene 1999).

DNR developed several methods to apply these new criteria to DNR's inventory data (Prenzlow-Escene 1999). Within each planning unit, the models sorted through DNR's inventory data to identify those places with any probability of occupancy.

3. Identify and release marginal habitat (lower quality)

Within each planning unit, DNR sorted the acres identified by the model to determine potential habitat quality from low to high. The HCP allowed lower quality areas, commonly referred to as marginal habitat, to be made available for harvest. The higher quality areas, commonly referred to as the reclassified habitat, were surveyed.



95% Reclassified habitat predicts where 95 percent of the acres expected to contain occupied acres are located.

5% Marginal habitat predicts where the lowest 5 percent of the acres expected to contain occupied acres.

4. Survey reclassified habitat (higher quality)

DNR conducted surveys on higher quality reclassified habitat.[8]

5. Develop a long-term conservation strategy

The information obtained during the previous steps, as well as other research efforts, shall be used to develop a long-term conservation strategy within each planning unit.

[8] In accordance with the HCP, surveyed, unoccupied habitat outside of Southwest Washington could be released for harvest if it is was not within 0.5 mile of an occupied site and after harvest, at least 50 percent of the suitable marbled murrelet habitat on DNR-managed lands in the watershed administrative unit remained. Within Southwest Washington, release of surveyed, unoccupied habitat is subject to the process used by DNR and USFWS to develop the long-term strategy. (HCP pp. IV-40, step 4)

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Appendix E. P-stage Focus Paper

Estimating the Location and Quality of Marbled Murrelet Habitat

Focus Paper #3

This focus paper was part of a series presented to the Board of Natural Resources in October and November 2015 to inform development of the marbled murrelet long-term conservation strategy alternatives. The purpose of this paper is to describe how DNR and USFWS identify and classify marbled murrelet habitat for purposes of developing the long-term conservation strategy.

Identifying marbled murrelet nesting habitat

Marbled murrelets were proposed for listing under the Endangered Species Act in part because their nesting habitat in older, complex-structured forests was thought to be so diminished by timber harvest that nesting opportunities were limiting the population (USFWS 1992). Contemporary research continues to support the importance of both *quantity* and *quality* of nesting habitat to murrelet distribution and abundance (e.g., Raphael and others 2015). For the development of a long-term conservation strategy, DNR and USFWS require a credible method, a "habitat model," to identify the current and potential future location and quality of marbled murrelet habitat across DNR-managed lands. Specific objectives for a habitat model were that it be:

1. Consistent with contemporary scientific findings on the relationships of murrelet nesting biology with forest characteristics,
2. Applicable to DNR-managed lands within the analysis area,
3. No more complex than necessary,
4. Geographic scale and resolution consistent with DNR forest inventory,
5. Appropriately consistent with independent habitat assessments on DNR-managed land, and
6. Consistent with data and models for forest structure and composition, growth, habitat quality and development.

Using forest inventory data

> **Marbled murrelet nesting habitat key components:**
>
> - **Nest platforms**
> - **Flight access to platforms**
> - **Security from predators**
> - **Located within 55 miles of marine habitat**

Murrelet nesting habitat is widely considered to have four components that interact to attract nesting murrelets and support their successful nesting: potential nest sites (platforms), flight access to the platforms, nest site- and neighborhood-level security from nest predators, and within commuting distance of marine habitat (considered to be 55 miles inland). The presence and abundance of platforms, and canopy complexity that enables flight access and provides site-level security are characteristics of forest stands[1] that can be evaluated using DNR's comprehensive forest inventory. This inventory includes data for stands across all DNR-managed forest lands. A variety of inventory measurements of live and dead trees, other plants, and site conditions are used to provide stand-level estimates of timber volume and value, growth potential, habitat potential, and other important attributes. These forest inventory data also provide the basis for identifying the location and quality of current and future murrelet habitat according to methods agreed upon by DNR and USFWS and described here. The resulting estimates are essential for purposes of conservation planning. Forest stands with high value as nesting habitat, or with the potential to develop nesting habitat characteristics within the HCP tenure, can be identified and incorporated in conservation strategies.[2] Likewise, these estimates can provide an objective basis for evaluating and adjusting forest management to arrive at a conservation strategy that meets the mandates of both DNR and USFWS.

What habitat classification models are available?

Since the marbled murrelet was listed under the Endangered Species Act in 1992, USFWS and DNR have used various methods to define and identify murrelet habitat.

Habitat modeling under the HCP interim strategy

The 1997 HCP includes an interim strategy that directs DNR to follow a stepwise process of increasingly focused identification and protection of habitat. The interim strategy has led to deferrals of harvest in the most important habitat (and some harvest deferrals in less important habitat) while DNR continues to gather knowledge about how and where marbled murrelets use habitat on DNR-managed lands. (See Focus Paper #4, "Occupied Sites," for a detailed description of the interim strategy.) The first step of the interim strategy is the identification of "suitable habitat blocks," which requires intensive fieldwork and has therefore been mostly applied to screen site-specific timber harvest proposals, rather than for comprehensive habitat inventory and conservation planning. This first step was followed by the development of habitat relationship models, planning-unit specific statistical models that used a suite of of stand and neighborhood-level characteristics to predict the likelihood of murrelet use (occupancy) based on HCP-directed murrelet research in a sample of 54 forest stands in each planning unit (Prenzlow

[1] A forest stand is a contiguous group of trees sufficiently uniform to be a distinguishable unit. Definition provided by Society of American Foresters. 1998. Dictionary of Forestry. http://dictionaryofforestry.org/dict/term/stand
[2] See Focus Paper #2, "Areas of Long-Term Forest Cover," for a description of how the strategy delineates these areas; see Focus Paper #5, "Potential Impacts and Mitigation," for a discussion of activities that may impact the murrelet.

Escene 1999).[3] Based on these models, habitat mapping ("reclassification") was done across DNR-managed lands in four planning units, and audio-visual murrelet surveys were conducted in that habitat to determine the extent of marbled murrelet occupancy and further refine implementation of the interim strategy. Note that habitat relationship modeling was not successful in the North and South Puget planning units; the interim strategy continues to use suitable habitat blocks to identify and protect habitat in those units.

Northwest Forest Plan modeling

Other comprehensive, region-wide habitat models have been developed for habitat inventory and monitoring to support the federal Northwest Forest Plan (1994). The "*Biomapper*" model was published in the ten-year review of the plan (Raphael 2006) and was used by the Science Team (Raphael and others 2008) in their analysis of murrelet conservation opportunities. Further work by the NWFP team led to updates using a different habitat modeling technique, "*Maxent*," the results of which were published in the fifteen-year and 20-year reviews of the Northwest Forest Plan (Raphael and others 2011; Falxa and Raphael 2015). The 20-year review provides the best available landscape scale estimate of the amount and location of murrelet habitat across all lands in Washington. It is not specific to DNR-managed lands.

Science Team modeling

In 2004, DNR convened a team of scientists to assess the state of knowledge on murrelets and their habitat on DNR-managed lands in order to provide recommendations on conservation opportunities. This "Science Team" published a report that included a habitat model that used DNR's forest inventory to predict current and future locations and quality of murrelet habitat (Raphael and others 2008).

Why have we selected the Science Team's classification model to estimate marbled murrelet habitat for the long-term conservation strategy?

For the long-term conservation strategy, DNR and USFWS sought a habitat classification model that would use DNR's spatially-explicit forest inventory data to credibly estimate the current and future location and quality of habitat. To be credible, the model needed to generally identify habitat where it exists, avoid and minimize "false positives" (identifying non-habitat as habitat), avoid and minimize "false negatives" (model not predicting habitat where it actually exists), and distinguish lower-quality habitat in structurally-simple stands from higher-quality habitat in older, complex-structured stands. Additionally, model predictions needed to be reasonably consistent with observed patterns of murrelet habitat use. The model known as "P-stage" was developed by the DNR Science Team to meet these criteria and is modified slightly here to reflect updated information and understanding. Development of the P-stage habitat model was described in detail by Raphael and others (2008, pp. 4.1 – 4.19) and is briefly summarized here, as are the current modifications.

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[3] See Focus Paper #4, "Occupied Sites," for a description of this survey and modeling work.

What is P-stage?

Probability of occupancy increased with stand development from the simple-structured, large-tree exclusion stage through the complex-structured, "fully-functional" stage.

P-stage is based on a conceptual model of marbled murrelet nesting habitat (e.g., Nelson 1997) as it relates to stand development in natural forests (e.g., Franklin and Spies 2002). It attempts to generalize and classify levels of habitat quality as it relates to forest stand characteristics. The model was developed by the Science Team using information from DNR-commissioned murrelet surveys, forest inventory, and forest growth modeling as well as general murrelet and silvicultural science.

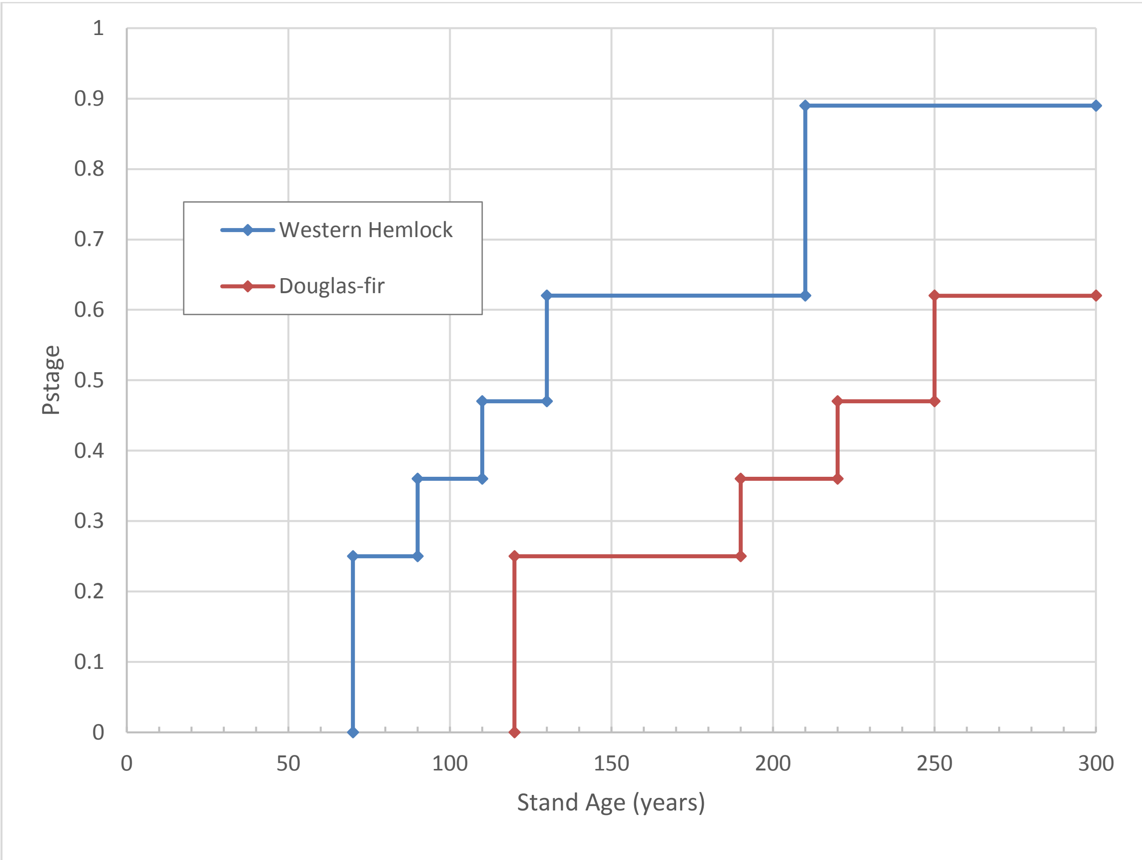
Developing the P-stage model

P-stage was developed by the Science Team in order to estimate murrelet habitat quality based on DNR's forest inventory. DNR commissioned murrelet surveys[4] to screen forest stands for murrelet use, resulting in their binary classification as occupied or not. Forest inventory data from 355 murrelet survey sites in southwest Washington were used in logistic regression analysis to estimate the probability of occupancy based on two forest attributes widely acknowledged to be important components of nesting habitat, platform abundance and canopy complexity. Platform abundance was estimated with the model used by Washington State Forest Practices (Duke 1997), which was developed with data from private forest lands in southwest Washington and is based on the relationships of platform presence and abundance with tree size. An algorithm that estimated canopy layering based on gaps in tree-height distribution (Crookston and Stage, 1999) provided an index to canopy complexity. Platform abundance, canopy layering, and their interaction (platforms * layers) were found to be associated with higher probabilities of occupancy, but were not perfect predictors. However, model predictions clearly supported that probability of occupancy (habitat quality) increased with stand successional development (DNR 2004) from the simple-structured "large-tree exclusion" stage at least through the complex-structured "fully-functional" stage (which provides functions of "old-growth"), as represented in the 355 sites in southwest Washington.

The Science Team examined this relationship of habitat quality increasing with platform abundance and canopy layering, observing that it paralleled patterns of stand successional development. The Team generalized a set of assumptions that quantified habitat quality as a function of stand age and dominant tree species composition (Raphael and others, 2008). Five stand development stages (DNR 2004) were assumed to have some value as murrelet habitat, and forest growth models were used to generalize the relationship of these five stages with stand age.[5] Stands were classified into stages based on forest inventory estimates of age and species composition, which also predicted the age at which a stand would transition into a higher quality stage (Figure 1).

[4] See Focus Paper #3, "Occupied Sites," for more details about occupancy surveys.
[5] See Figures 4-2 and 4-3 in the Science Team Report (Raphael and others, 2008).

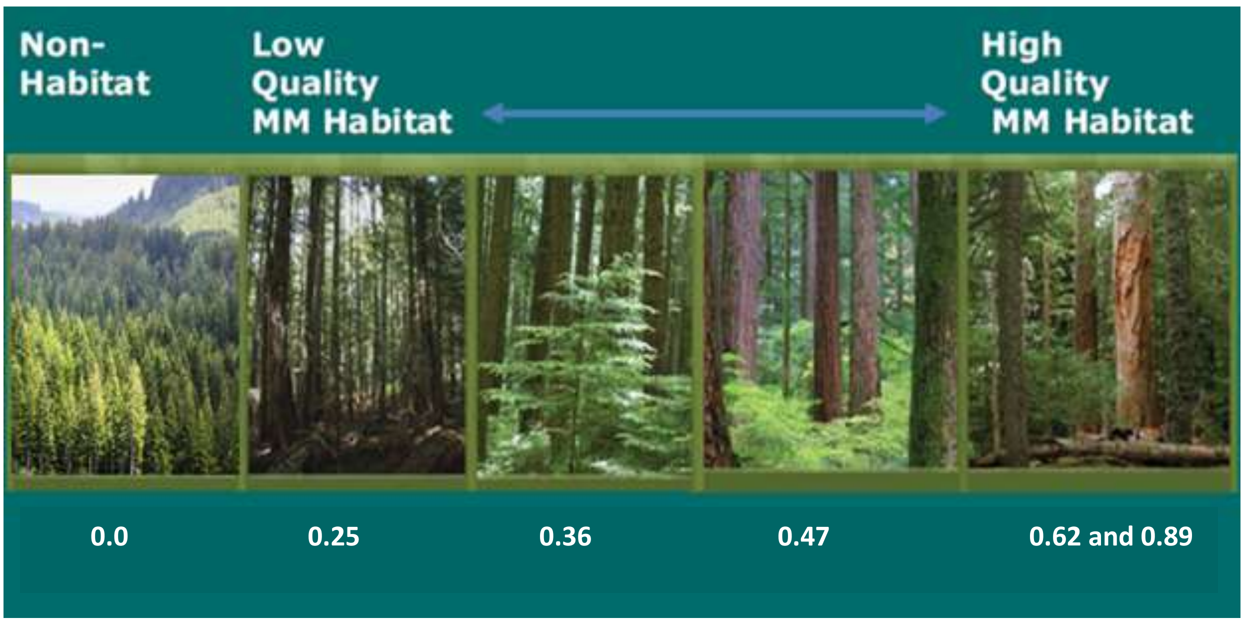
Figure 1. Ages at Which Naturally-Regenerated Forest Stands Transition among P-stage Categories according to the P-stage model



Stands dominated by Douglas-fir rather than western hemlock or other shade-tolerant species were predicted to develop habitat quality more slowly (Raphael and others, 2008). The value that indexed "habitat potential" based on stand development stage was called P-stage to reflect its origins in the logistic regression analysis that predicted "p," the probability of use. Stands were classified as non-habitat (P-stage 0) or as one of five stages of increasing quality (.25, .36, .47, .62, .89), from the lowest-quality stage that had consistent use (large tree exclusion) to the stage with the highest usage rates (fully-functional) (Figure 2). Those assumptions were used to evaluate conservation opportunities on DNR-managed lands in southwest Washington and the Olympic Peninsula (Raphael and others, 2008).

The value that indexed "habitat potential" based on stand development stage was called "P-stage" to reflect its origins in the logistic regression analysis that predicted "p," the probability of use.

Figure 2. How the P-stage Model Associates Key Stand Characteristics with Stepwise Development of High Theorized Marbled Murrelet Habitat



Updates to the P-stage model

The P-stage model of Raphael and others (2008) was modified slightly to apply more broadly across all DNR-managed forests in western Washington and to incorporate updated information and understanding of murrelet habitat and stand development. The most significant update was to the plan area, which was expanded beyond the four coastal HCP planning units analyzed by the Science Team to include the North and South Puget planning units. This approximately doubled the analysis area. Stand origin categories of naturally regenerated versus planted were included to avoid predicting that late 20th century plantations with few or no legacy trees would develop into habitat during the 50-year analysis projections. This would allow model predictions of habitat development in naturally-regenerated stands that often include considerable biological legacies due to historical timber harvest methods. Small adjustments were also made to the predicted rates of transition among P-stage classes (Table 1). The Science Team applied P-stage values to forest habitat within 40 miles of high-use marine habitat (Raphael and others 2008) and discounted those values by 0.25 at greater distances; the current approach applies the values to all habitat within 55 miles of marine water, with discounts applied to some regions with little or no documented murrelet use (see Focus Paper #5, "Potential Impacts and Mitigation," for a description of how P-stage values are adjusted for geography and edge effects across the landscape). An additional adjustment acknowledged the demonstrably high value of known *occupied* habitat, which was classified as P-stage 1 (a value not represented in the Science Team report).

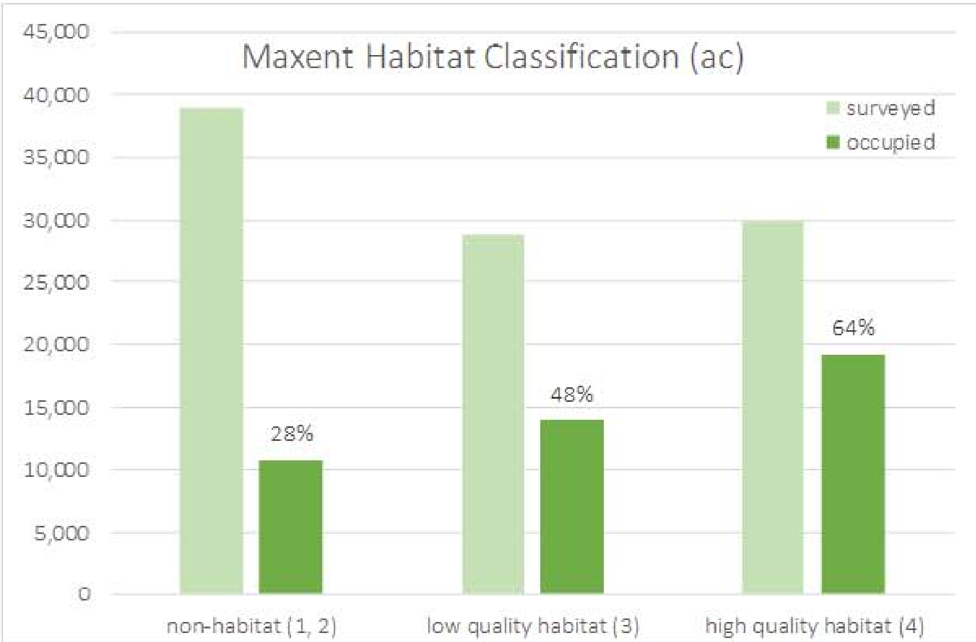
Table 1. Ages at which stands transition among P-stage categories, by dominant tree species, for modelling decisions

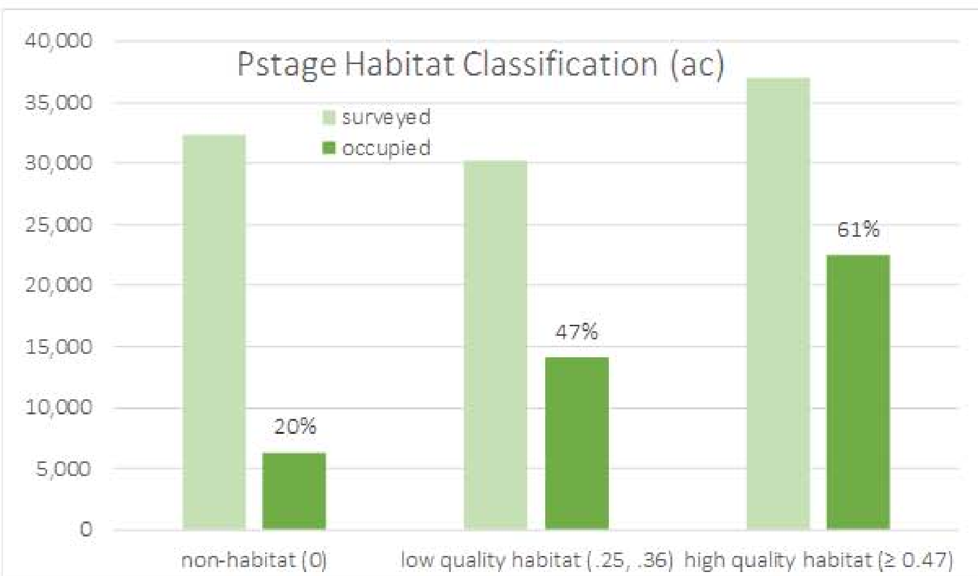
	Relative Stand Age (years)	
P-stage (value)	**Western hemlock**	**Douglas-fir**
0.25	70	120
0.36	90	190
0.47	110	220
0.62	130	250
0.89	210	NA

How does P-stage compare to other models in estimating habitat?

To evaluate a model's performance, the normal procedure is to compare predicted results with an observed set. The ratio of observed over predicted results provides a measure of the model's performance. Because there are no agreed upon biological definitions of murrelet habitat or habitat quality, it is not possible to have an observed data set that captures varying habitat quality. Instead, evidence regarding the accuracy of Maxent and P-stage predictions was gathered by examining model predictions at DNR murrelet survey sites comprising nearly 100,000 acres (see Focus Paper #4, "Occupied Sites," for a description of these surveys). Given the hypothesis that murrelets avoid non-habitat and preferentially occupy higher-quality habitat, the ratio of occupied to surveyed acreage (occupied ÷ surveyed) should be near zero for non-habitat, and increase as model-predicted habitat quality increases. Falxa and Raphael (2015 in press) summarize Maxent categories 3 and 4 as habitat and categories 1 and 2 as non-habitat. They also consider categories 3 and 4 to represent a gradient in habitat quality. Figure 3 suggests that both P-stage and Maxent predictions are in accord with the murrelet's hypothesized pattern of habitat use, although both models identify significant portions of occupied sites as non-habitat.

Figure 3. Habitat Classification by the Maxent and P-stage Models for DNR-Managed Land Surveyed for Murrelets and for Occupied Sites Located with those Surveys (percentages reflect occupied/surveyed acres within classes)

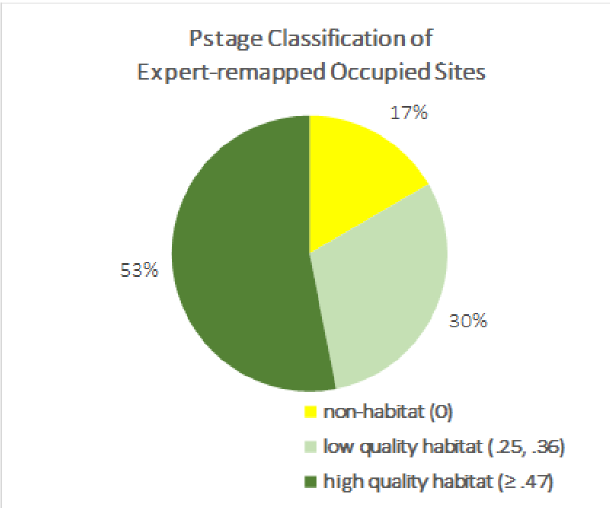


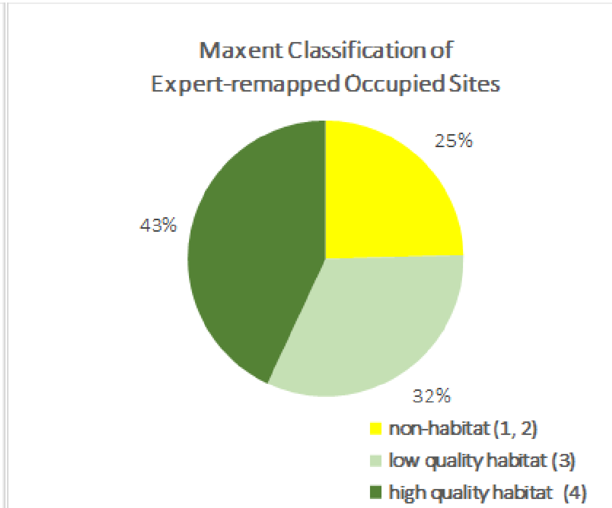


Expert review (Raphael and others 2008) of occupied sites as they were originally mapped under the HCP resulted in the delineation of approximately 16,000 more acres (including surveyed and unsurveyed areas) asoccupied habitat. Assuming that this expert re-mapping provides a more biologically appropriate delineation of murrelet habitat, Maxent and P-stage habitat classifications of those re-mapped occupied sites can also be evaluated. Model-based estimates of the composition of those areas should conform to the prediction that occupied murrelet sites are predominantly higher quality habitat, with lesser amounts of low quality habitat and little non-habitat.

As illustrated in Figure 4, both models do identify that predicted distribution, with higher quality habitat comprising the most abundant group under Maxent (43%) and P-stage (53%) classifications. However, both models identify significant amounts of occupied sites as non-habitat, Maxent 25% and P-stage 17%.

Figure 4. Maxent and P-stage Classifications of 61,000 acres of Expert-mapped Occupied Murrelet Sites on DNR-Managed Land (percentages are class/total area of occupied sites)





It appears that both Maxent and P-stage provide reasonably consistent habitat estimates for areas surveyed for murrelets and for areas found to be occupied. Model predictions of habitat classes at occupied sites provide information on the ability of the respective models to identify habitat where it exists and suggest that while both models perform "reasonably," neither model can identify all habitat. While evidence is less direct, some of the model-predicted habitat by either model that was found unoccupied with surveys may actually be non-habitat. However, the general alignment of both models with predictions based on murrelet biology, the gradient of occupancy rates found with murrelet surveys and the composition of occupied sites, suggests that either model provides appropriate estimates of current location and quality of habitat.

Although no conclusive comparisons of model performance can be made, habitat predictions of the P-stage model align slightly better with hypothesized murrelet habitat relationships, with a lower occupancy rate in non-habitat (Figure 3) and higher proportions of habitat and high-quality habitat composing occupied sites (Figure 4). P-stage appears to be the best available stand-level murrelet habitat model for DNR-managed land because it is the only model that meets all requirements of USFWS and DNR for development and assessment of the long-term conservation strategy (Table 2).

Table 2. Criteria-based Comparison of Three Habitat Classification Models

Model Criteria	P-stage	Maxent	Interim Strategy (reclassified model)
1.Based on relationship between nesting biology and forest composition	✓	✓	
2. Applicable to all DNR-managed lands in the analysis area	✓	✓	
3. Simple rather than complex	✓		
4. Scale and resolution consistent with DNR forest inventory	✓		
5. Habitat classifications demonstrably consistent with contemporary murrelet science	✓	✓	✓
6. Consistent with DNR forest modeling	✓		

How do we address uncertainty in P-stage model predictions?

Hilborn and Mangel (1997) describe two broad types of uncertainty that influence our ability to make inference from ecological models: 1) uncertainty in generalizing and quantifying ecological *processes*, and 2) uncertainty in ecological data gathered from *observations*. Both process and observation uncertainty affect conclusions derived from the P-stage habitat model. Murrelet biological responses (processes like habitat selection, nesting rates, and nest success) are more variable and unpredictable than can be acknowledged within our simplistic model of habitat quality, or in the binary classification of murrelet habitat as "occupied" or not. Likewise, forest structure, composition, and growth are processes that are more complex and subject to many more influences than can be incorporated into the P-stage model. Findings from our sample-based forest inventory and murrelet surveys can be influenced by sampling and measurement error and other forms of observation uncertainty.

Predictions of the P-stage model cannot be perfectly accurate; the model classifies habitat quality by discrete groups, while habitat quality in nature is more likely a continuous gradient. Murrelets likely select habitat based on a more complex suite of environmental cues than platform abundance and canopy layering, and further specificity is lost in the generalization of those elements of stand structure by age-class. Because of these and other uncertainties, some habitat will be overlooked, some non-habitat will be mistakenly identified as habitat. Some habitat will also be mistakenly classified as higher or lower quality than its actual state, and transitions among habitat quality classes will not perfectly follow predictions. Some of these uncertainties and their possible influences on evaluating and selecting a conservation strategy are summarized and discussed below.

If P-stage predictions were consistently biased, there would likely be a directional effect on outcomes of the conservation strategy. For example, if model predictions consistently under-estimated habitat quality, habitat conservation would likely be less effective because some current habitat and forests that would grow into habitat will be overlooked. If habitat quality were consistently over-estimated, habitat conservation would likely be less efficient because some non-habitat would be assigned to conservation pathways but would not serve its intended purpose. Unbiased error can also affect conservation outcomes with effects of under- and over-estimates as noted above, but if those errors were approximately balanced then their effects would be manifest but diluted compared to consistent, directional error. Key components of the P-stagemodel are examined for theory and/or evidence that could suggest its predictions are biased.

Scale and resolution. The scale at which murrelets select nesting habitat is not known. Clearly, these seabirds need an appropriate nest platform in a context that provides stability and security during the nesting season. Across the nearly 3,000 miles of coast they inhabit in North America, those fine-scale elements of nesting habitat are rather constant but as the view expands beyond the immediate nest site, the environment becomes increasingly indistinguishable from its surroundings (McShane et al. 2004). This uncertainty over the scale at which habitat is distinguished from non-habitat, and how to distinguish among levels of habitat quality is likely responsible for much uncertainty in all habitat modeling and delineation exercises. Raphael et al. (2015) discuss this source of uncertainty in their Maxent model which predicts and maps murrelet habitat across three states at the scale of 30 m square pixels (the resolution of their satellite imagery), generalized from characteristics of the target pixels and its immediate neighbors (9 pixels total, approximately 2 acres) although their multivariate habitat model also incorporates broader-scale influences from the surrounding 50 hectares (147 acres). The P-stage model predicts and maps habitat over DNR-managed land at the scale of forest inventory units (i.e., stands as footnoted above) which average 48.7 acres in western Washington with 82% of nearly 19,000 stands between 5 and 100 acres. Stand-level metrics are developed from on-ground measurements at a network of sample plots located at approximately one plot per five acres. The “suitable habitat block” model, which has been mainly used for project-level planning and implementation, identifies and delineates habitat based on tree-by-tree inspection and arbitrary thresholds for the density of platforms observed (two per acre), the inter-tree distance between platform-bearing trees (300 feet, 92 meters), and minimum patch size (five acres).

Wiens (1976) cautioned researchers to avoid our human preconceptions and focus habitat research at scales important to the organisms of interest. Absent knowledge of the scale, or scales at which murrelets recognize and select nesting habitat, the habitat models noted above mainly focus around human perceptions of forest habitat at scales appropriate to the geographic scope of their unique applications (range-wide, estate-wide, project-level) using the resolution of available data. Thus even if each model classified habitat similarly, their mappings would differ because small habitat areas or inclusions of non-habitat would be variously overlooked depending on resolution. If murrelet habitat consistently occurred in habitat patches too small to be recognized with DNR’s forest inventory, P-stage would fail to identify much habitat. However, the consistent broad-scale relationship of murrelet numbers with habitat area as identified with a variety of habitat models (Burger 2002, Raphael and others 2002, Raphael and others 2015) and the consistent patterns of murrelet inland habitat use in identifiable habitat patches (i.e., “stands”) as identified with a variety of methods (e.g., McShane and others 2004) suggest that the scale and resolution of P-stage predictions are appropriate to identify most murrelet habitat.

Forest stands. Forest stands, by definition, are a construct of human perception. DNR’s current forest inventory is collected at sample plots, which comprise approximately one percent of stand area for overstory trees (where potential murrelet nest sites occur). Thus, even though stands were delineated from high-resolution aerial photography based on apparent similarity of vegetation and topography, considerable fine-grained heterogeneity within stands is obscured when stand level averages are compiled from plot data. Consequently, discrete areas of habitat could be missed within stands with average characteristics of non-habitat or vice-versa. Some murrelet nests have been located in what appear to be unsuitable forest conditions (Bradley and Cooke 2001, Bloxton and Raphael 2009) although they were generally in landscapes dominated by older forest. These discoveries probably reflect the inability of coarse-grained, stand-level classifications to recognize rare structural elements or small patches of murrelet habitat. However, the great majority of murrelet nests have been located within forests more broadly recognizable as murrelet habitat (e.g., McShane and others, 2004), lending confidence that stand-level habitat classification can identify most murrelet habitat.

Forest growth, stand characteristics, and habitat development. The P-stage model simplifies the relationship of murrelet habitat quality with stand development to three stand characteristics: origin, dominant species, and age. But forest growth and the development of murrelet habitat that accompanies it are much more complex and unpredictable processes than represented by that simple model. Observation uncertainty in the forest inventory-based estimates of stand characteristics adds to the uncertainty that accompanies P-stage predictions of habitat quality. However, comparison of P-stage classifications with murrelet survey findings (Fig. 3) and habitat mapping at occupied sites (Fig. 4) do not suggest that P-stage provides biased estimates of murrelet habitat quality.

Field observations. Some areas predicted as murrelet habitat by P-stage appear to lack abundant trees with platforms and/or individual trees with abundant platforms. Likewise, some predicted non-habitat contains trees with platforms and some of the area mapped as occupied is classified by P-stage as non-habitat. These observations can be proposed as evidence that P-stage mistakenly classifies some non-habitat as habitat and overlooks other habitat. However some areas mapped as occupied were found to lack platforms as well, lending an additional dimension of uncertainty to comparisons of expert- and model-based habitat predictions. While some habitat is certainly overlooked just because of the scale issues summarized above, it is more difficult to contend that non-habitat is mistakenly classified as habitat because of the probabilistic nature of P-stage predictions. For example, P-stage 0.25 is so classified because stands with that general suite of characteristics are occupied about one-fourth as frequently as the highest quality habitat. The generalized probability of use that P-stage classes represent encompasses within-class, among-stand variability in habitat quality, behavioral variability among murrelets, and other sources of variability. Thus the lack of observable habitat characteristics in some P-stage habitat can be considered to be within the scope of model predictions. The overall patterns of “selection” among P-stage classes found with DNR murrelet surveys (Fig. 3) and the classification of habitat identified as belonging to occupied sites (Fig. 4) demonstrates the general applicability of the model even though some predictions do not conform to field observations.

Planning with uncertainty

> **The Joint Agencies conclude that there is an unknown level of uncertainty in P-stage predictions of current and future habitat, but also that the general applicability of P-stage model predictions outweigh their uncertainty.**

The Joint Agencies conclude that there is an unknown level of uncertainty in P-stage predictions of current and future habitat. However, the general applicability of the P-stage model predictions outweigh their uncertainty for this conservation planning effort. We can acknowledge this uncertainty and proceed with developing and implementing a conservation strategy using P-stage habitat predictions for three basic reasons: 1) the apparent prevalence of reliable model predictions relative to those clouded by uncertainty, 2) the need to develop and implement a conservation strategy with this uncertainty in mind , and 3) existing policies and management procedures, as well as conservation planning approaches safeguard against high levels of risk associated with this uncertainty. Those additional cautions include:

1. Habitat conservation is geographically extensive in all alternatives.
2. Occupied sites were expanded to include sites where above-canopy circling was observed, and to include expert-identified contiguous habitat regardless of survey findings or previous habitat classification. Protection of expanded occupied sites and buffers are a component of all but one alternative.
3. All alternatives propose to retain the majority of identified current and potential future habitat.
4. Current and future habitat is abundant in LTFC. It is likely that much of the "overlooked habitat" is prevalent in LTFC and is already in conservation status.
5. Some alternatives propose the retention of all "higher quality" habitat.
6. Under most alternatives, the majority of habitat conservation and development occurs nearby but outside of occupied sites.
7. Estimation of impacts and mitigation are based on the same assumptions so there is an intrinsic balance.

How is P-stage applied in the development of the long-term strategy?

P-stage is being used for the long-term conservation strategy as a baseline for determining habitat quantity and quality on DNR-managed lands over the life of the HCP. P-stage values are used to identify key areas to focus conservation, as well as in the calculation of take and mitigation. It is important to recognize that there are other factors that influence the probability of occupancy of a forest stand by murrelets, including proximity to high-quality marine habitat, proximity to other occupied sites, and habitat fragmentation. The P-stage model does not, by itself, account for these factors when evaluating habitat. However, the analytical framework adjusts P-stage values to reflect edge effects, geographic location, and other important factors affecting habitat quality (see Focus Paper #5, "Potential Impacts and Mitigation"). In addition, the conservation alternatives being developed account for these factors when designating potential habitat for long-term protection under the HCP.

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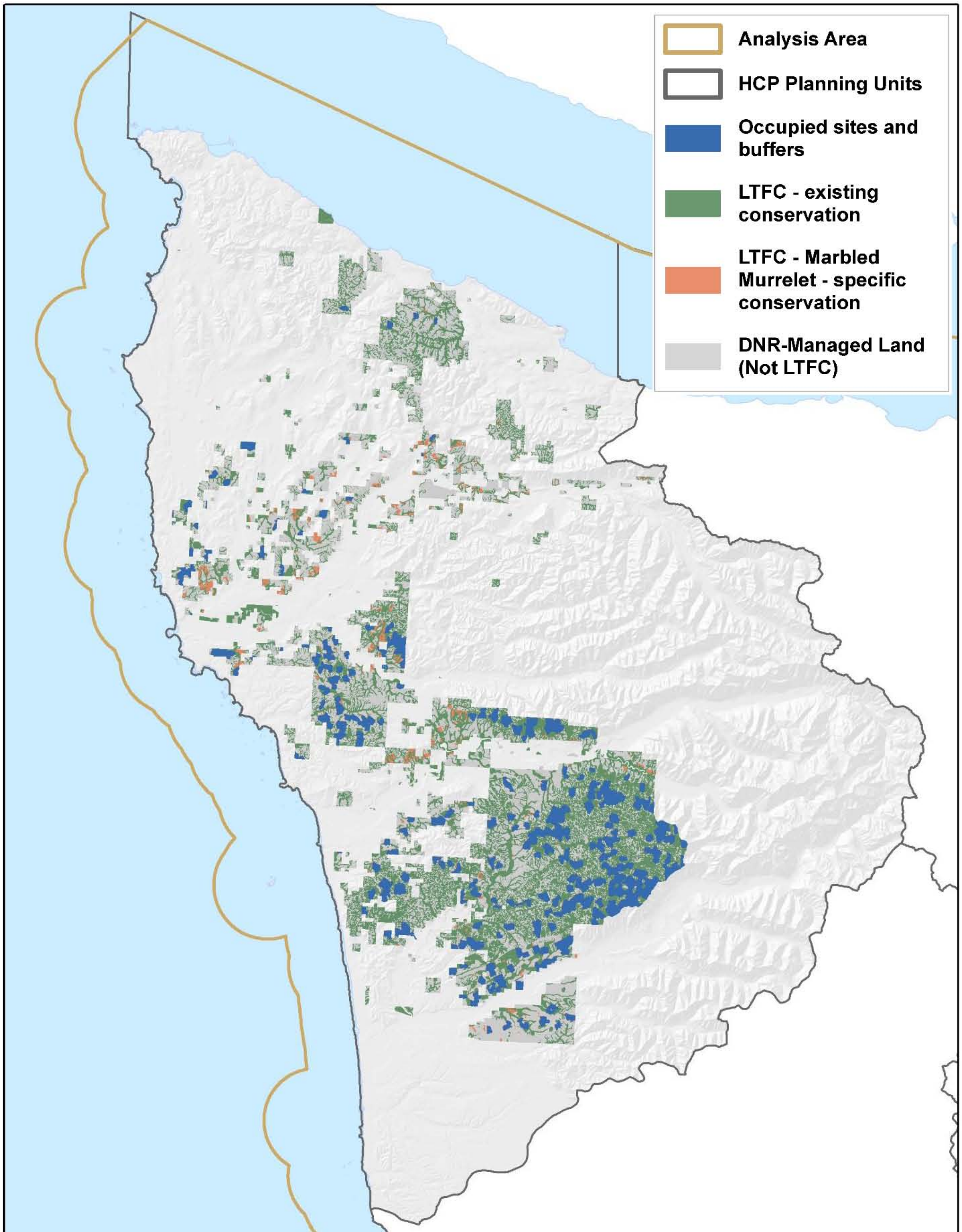
Appendix F. Maps of Marbled Murrelet Conservation Areas by Alternative

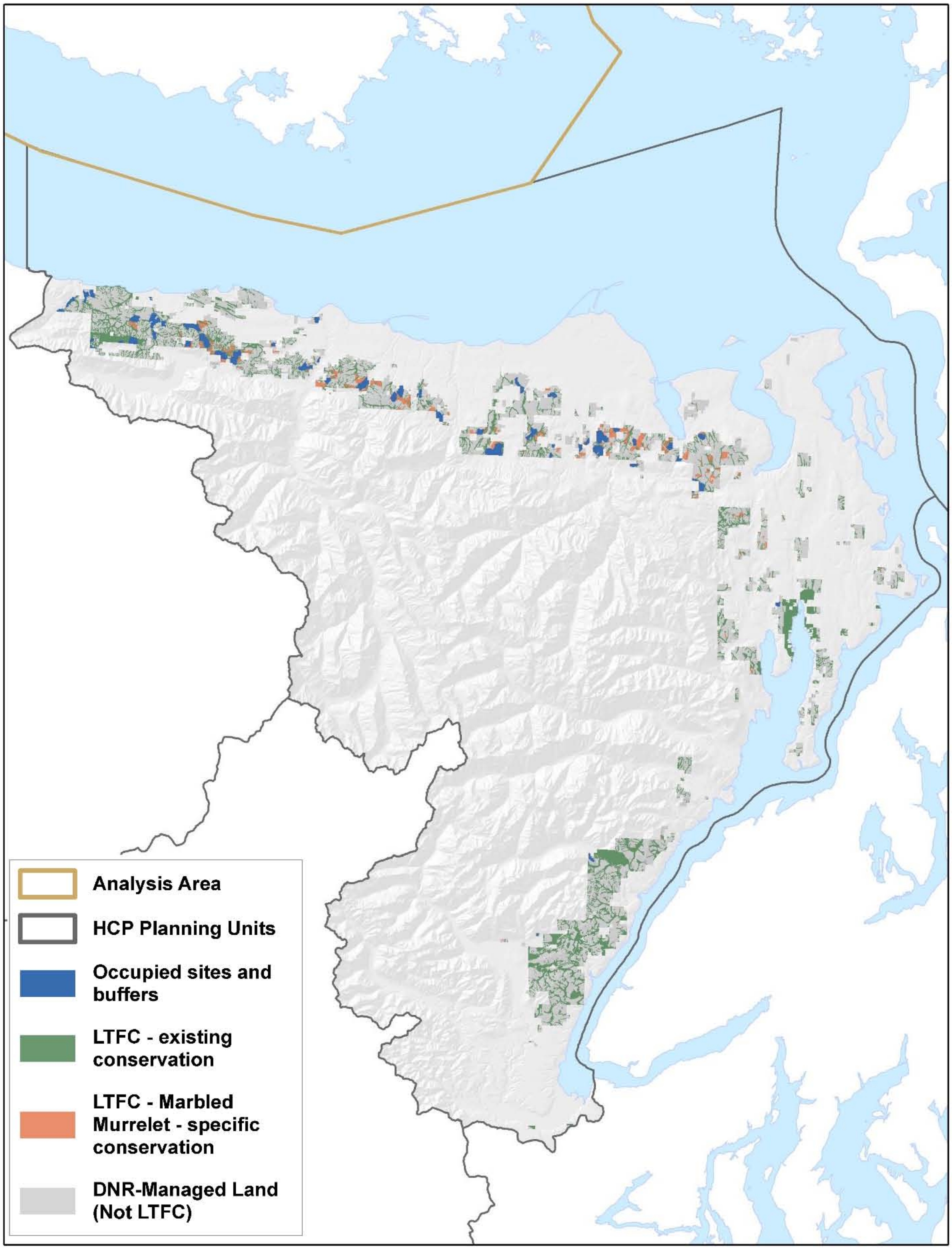
Maps in this section are provided at various scales to illustrate proposed conservation areas for each alternative. Maps showing each planning unit are provided for every alternative. In addition, for those alternatives with emphasis areas, special habitat areas, and/or marbled murrelet management areas (MMMAs), "zoomed in" maps are provided to more clearly identify the location of these conservation areas.

Emphasis areas, special habitat areas, and MMMAs are labeled with unique identifiers (names or numbers) for reference purposes only.

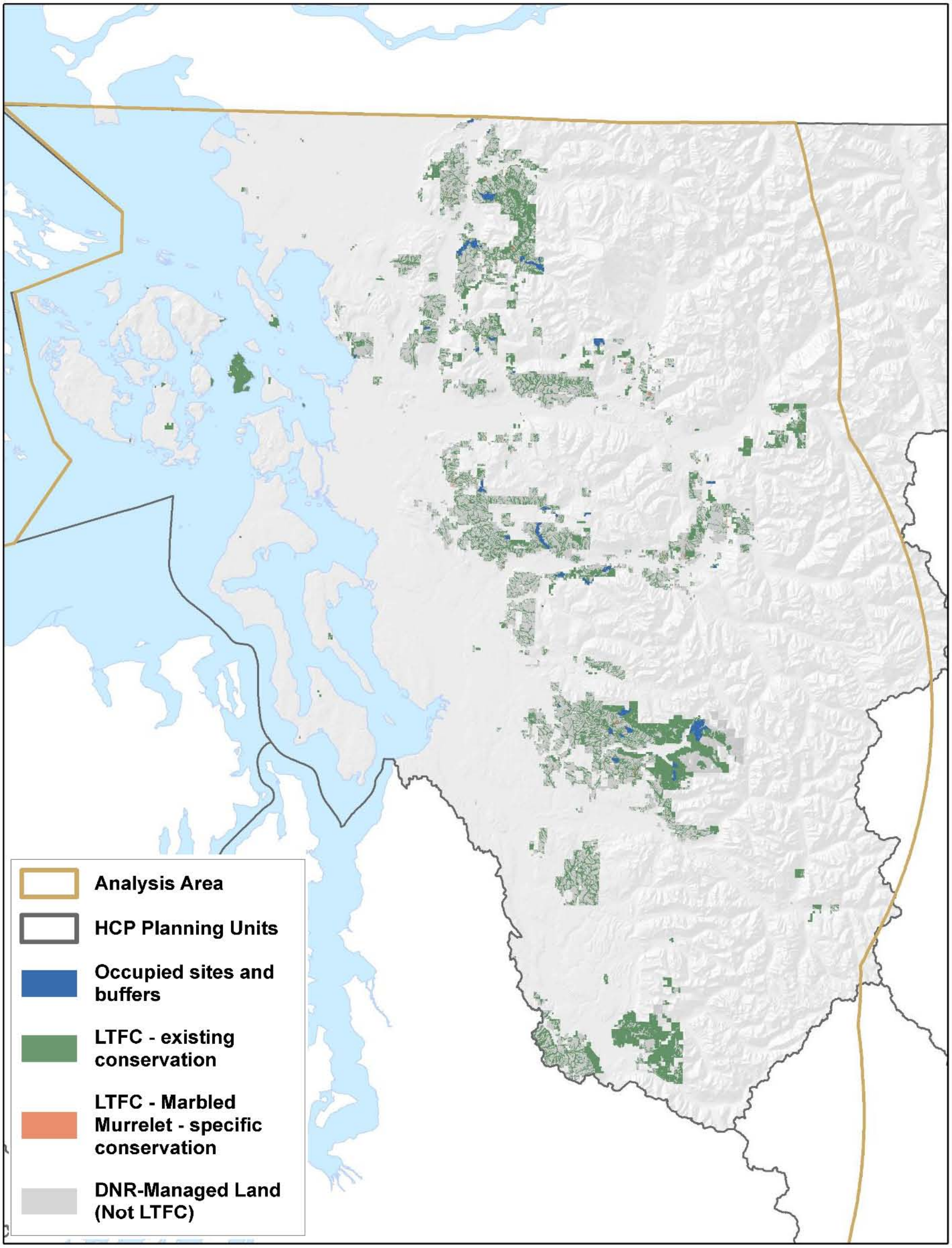
Alternative A: OESF planning unit



Alternative A: Straits planning unit

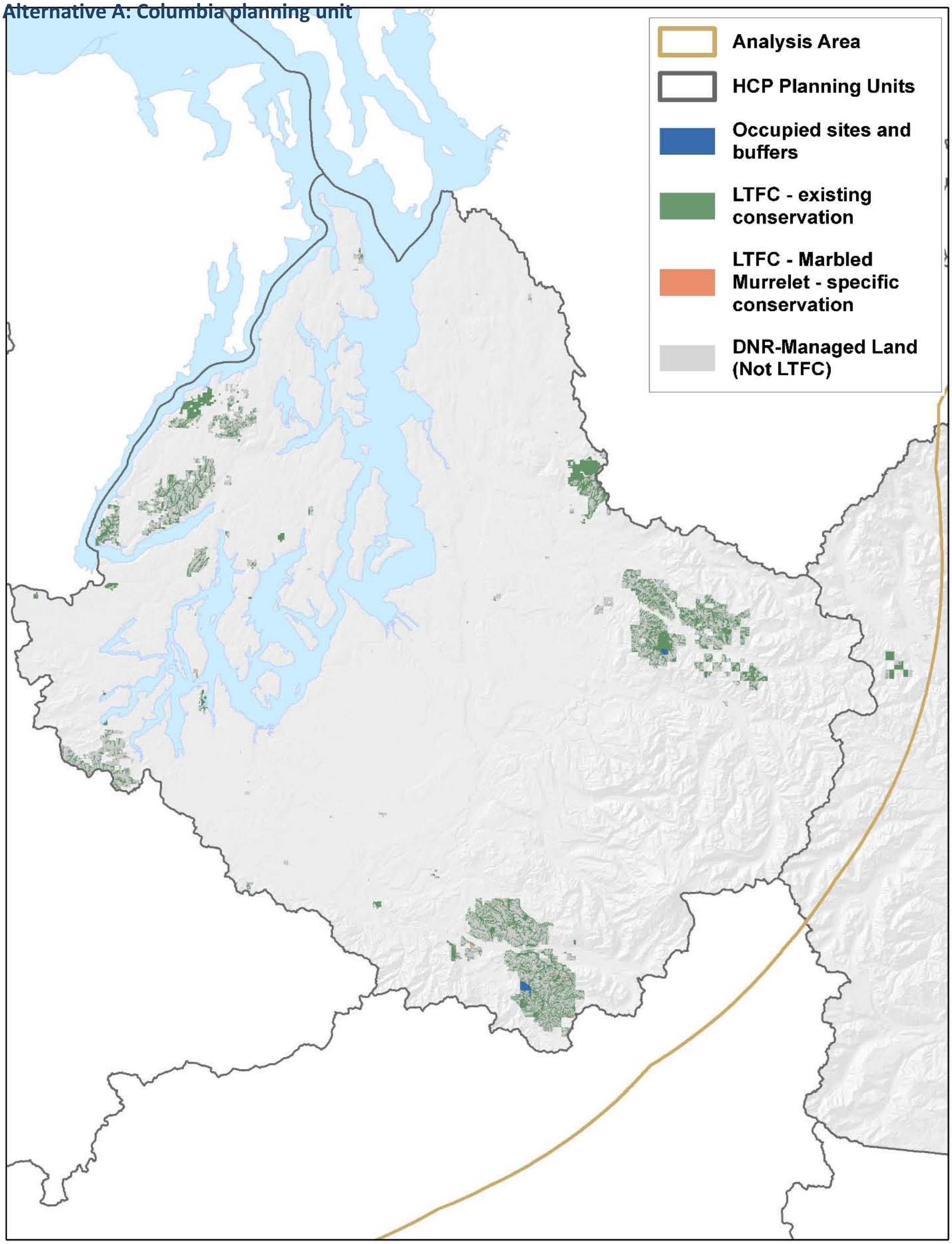


Alternative A: North Puget planning unit

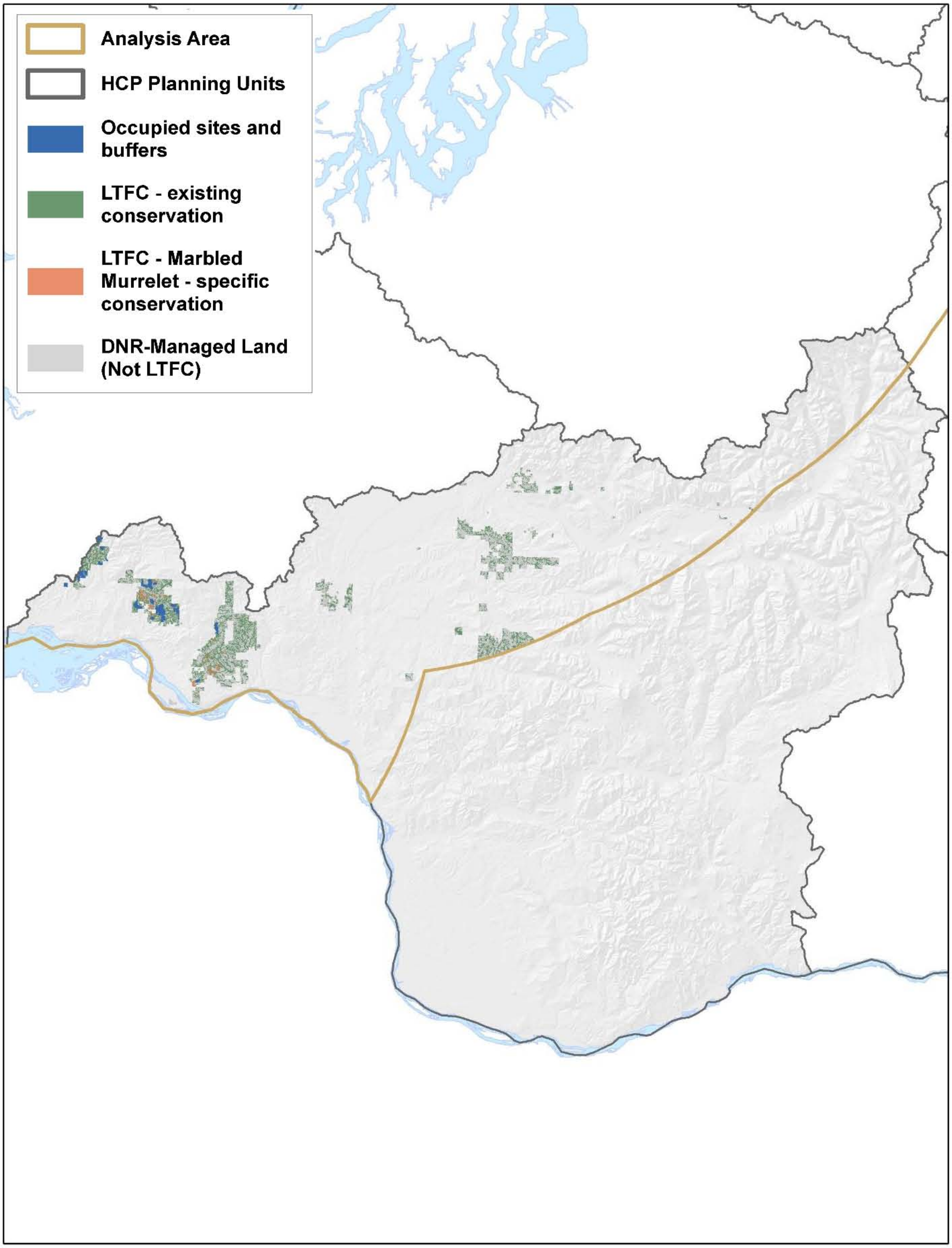


Alternative A: South Puget planning unit (includes small portion of Yakima planning unit)

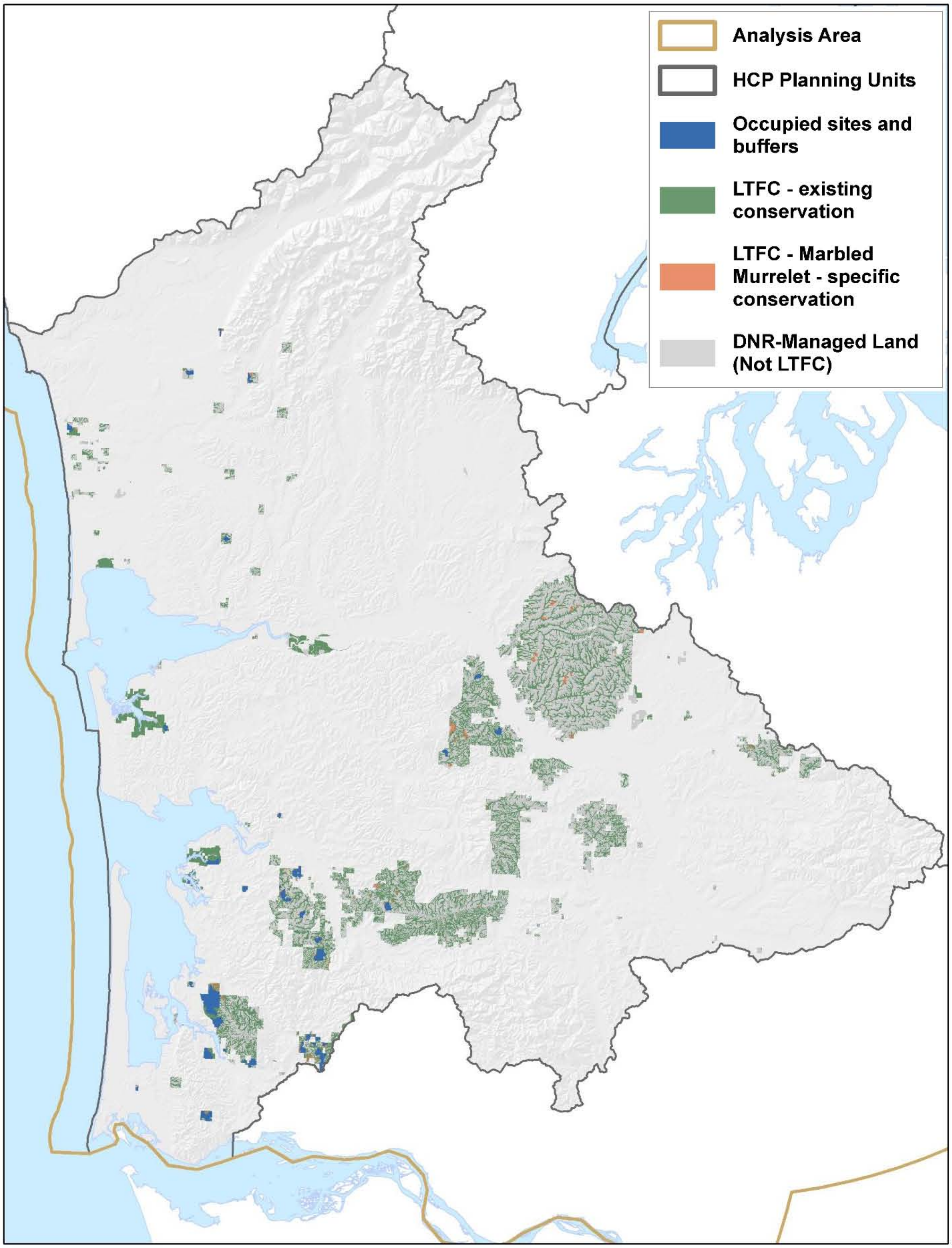
Alternative A: Columbia planning unit



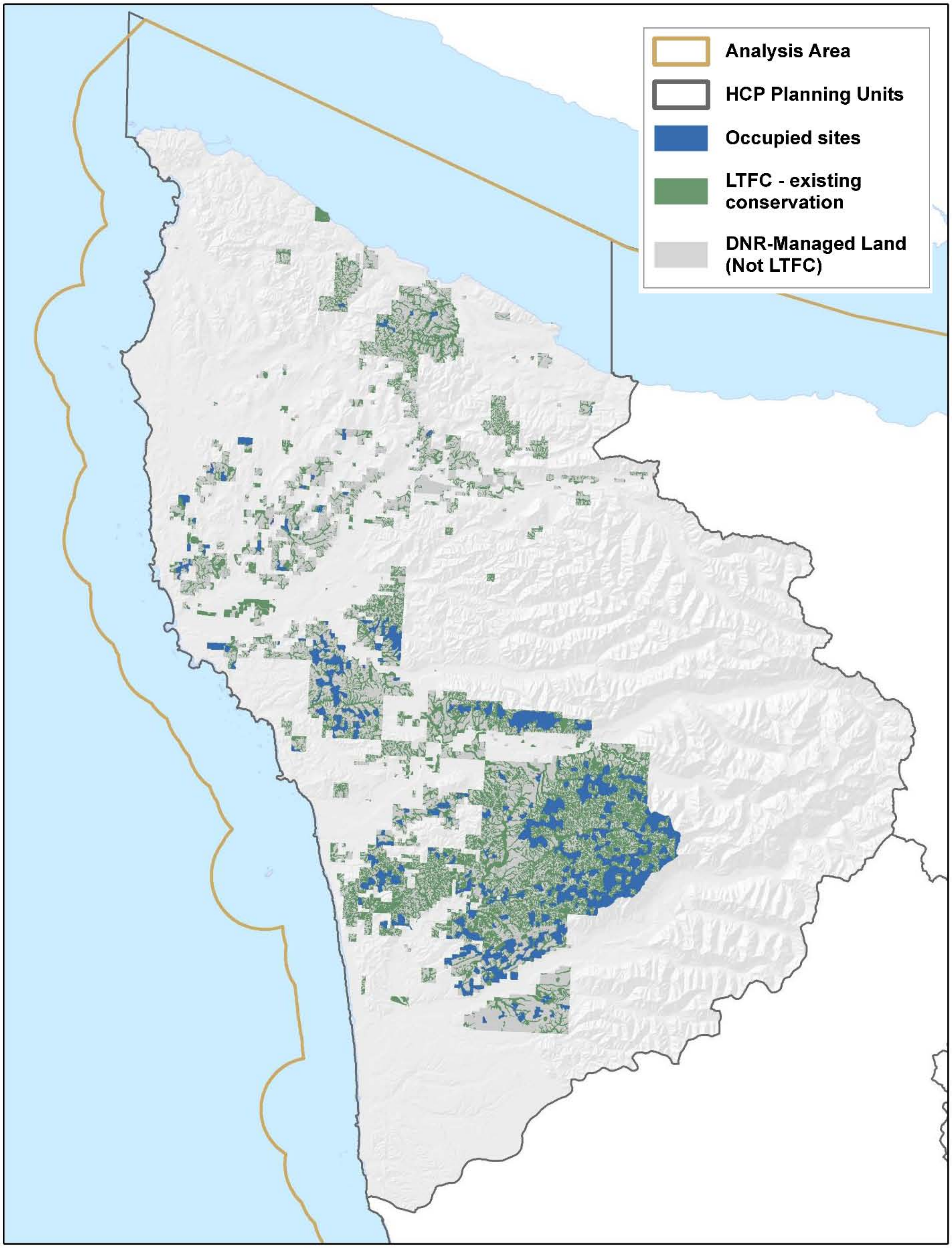
Alternative A: Columbia planning unit



Alternative A: South Coast planning unit



Alternative B: OESF planning unit



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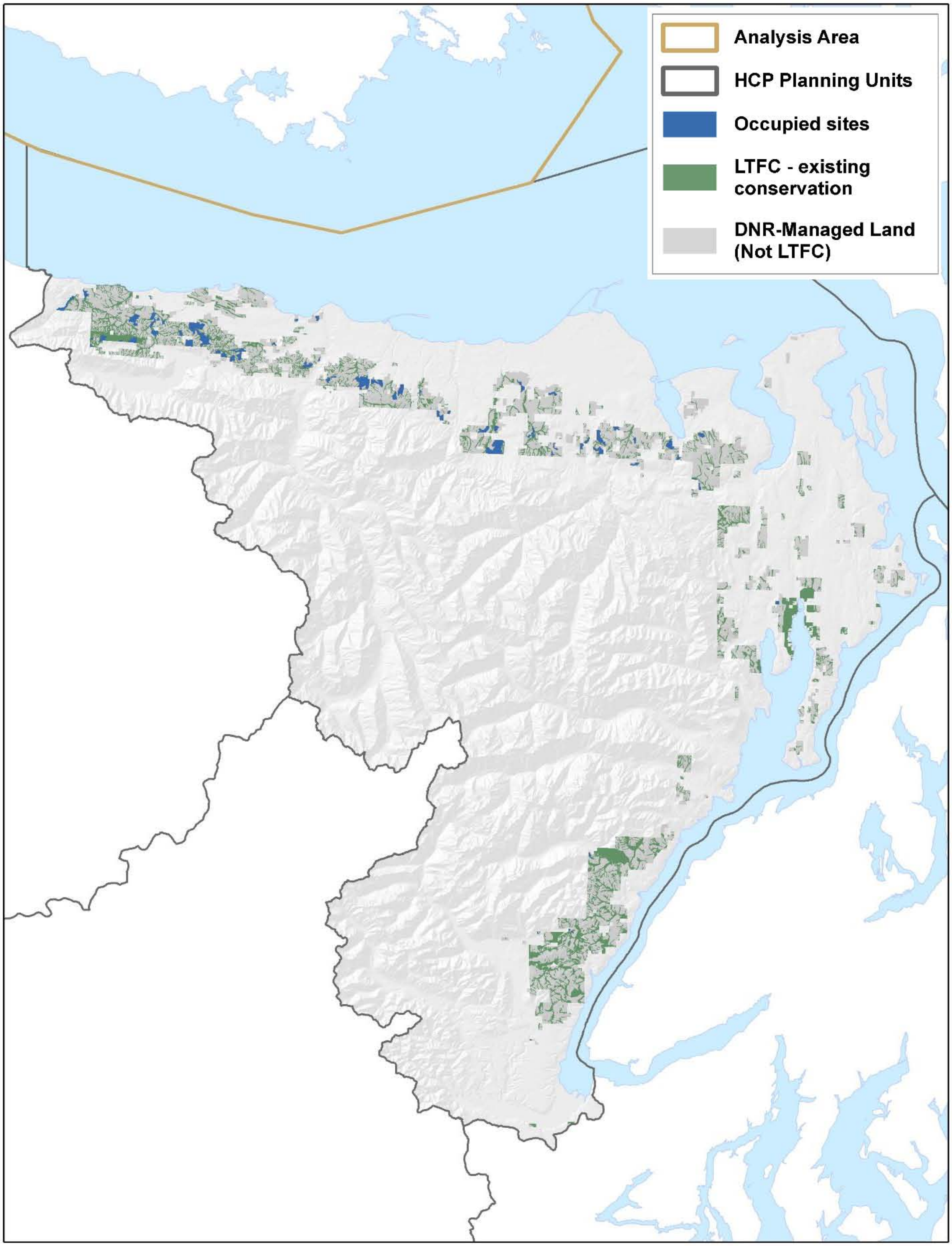

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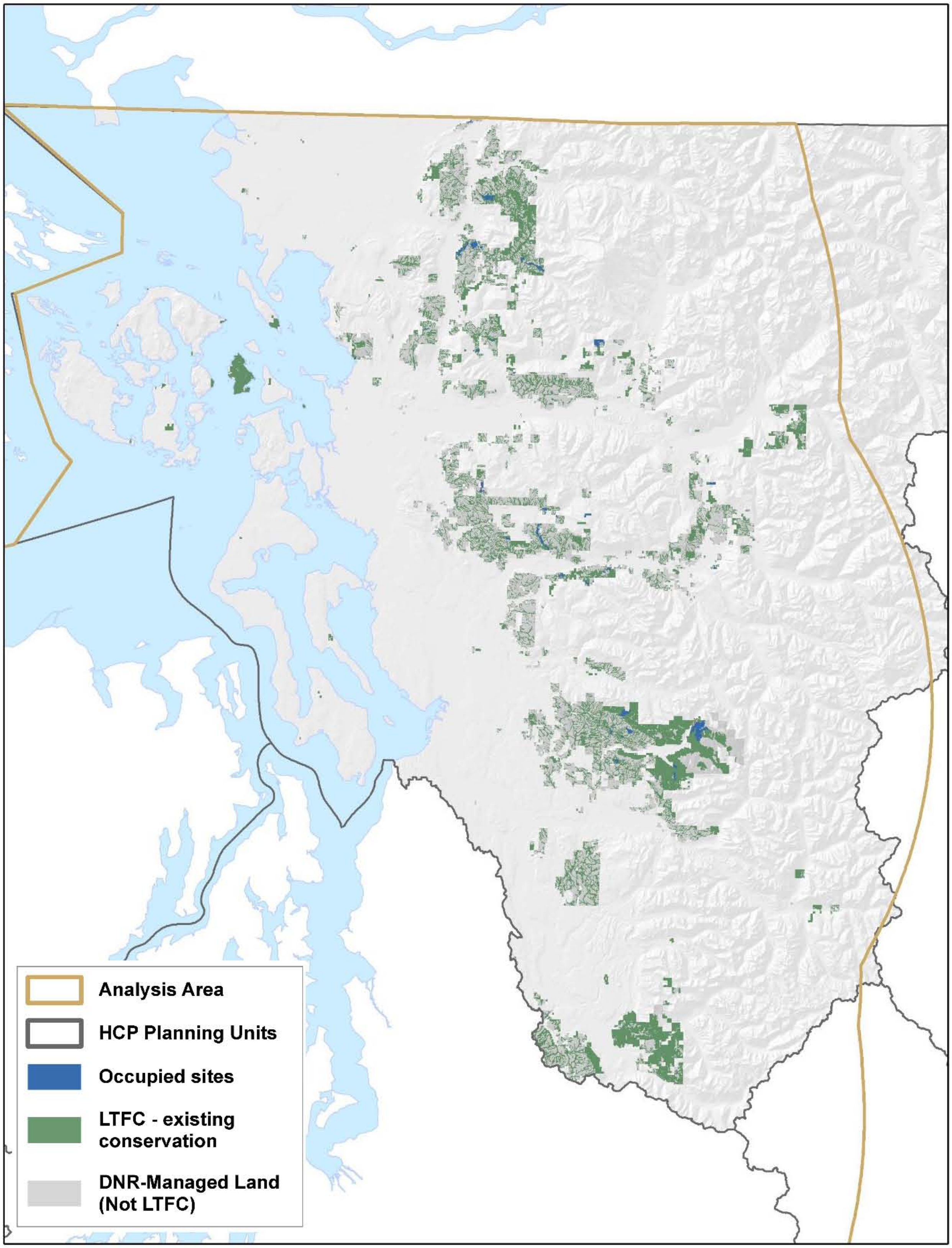
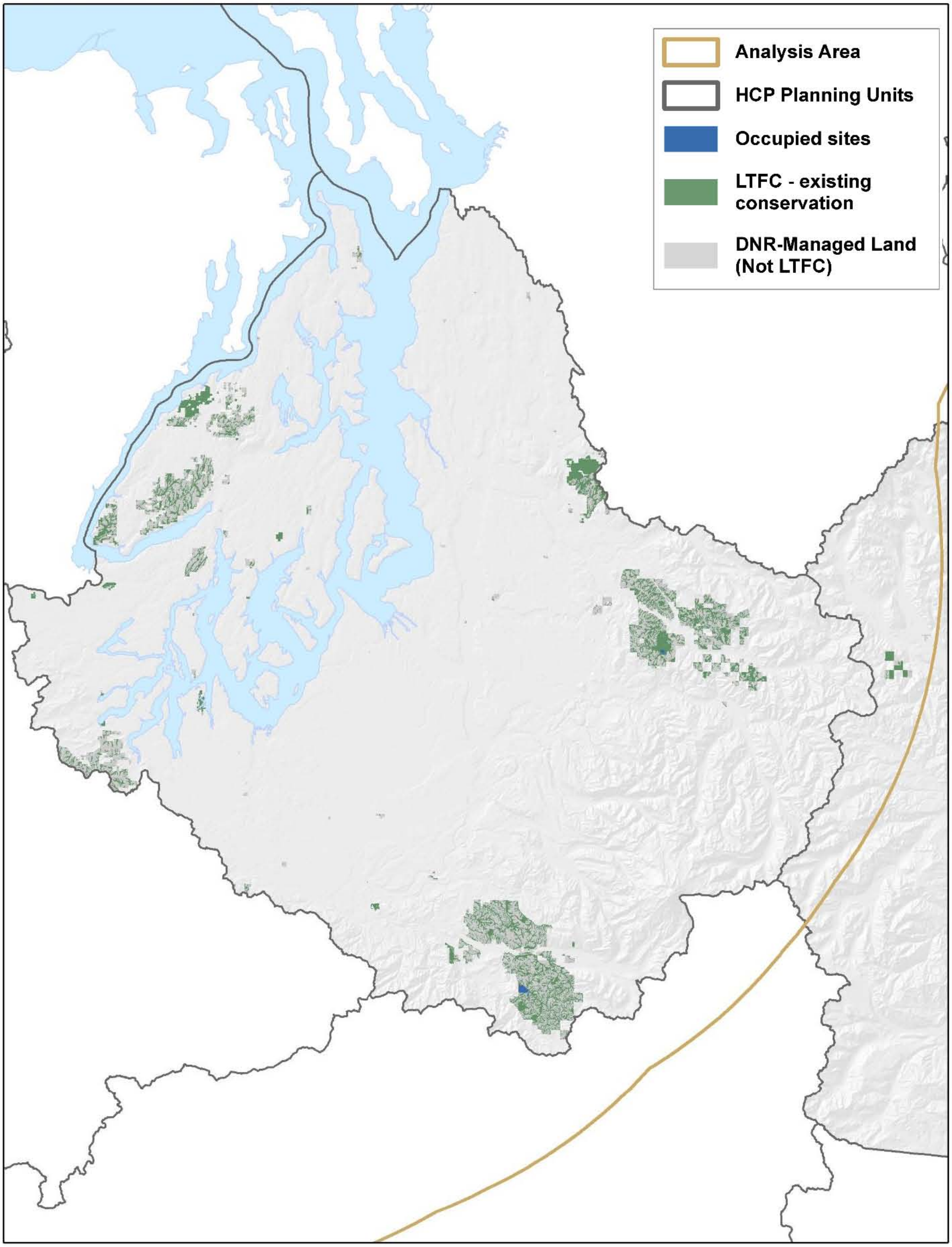
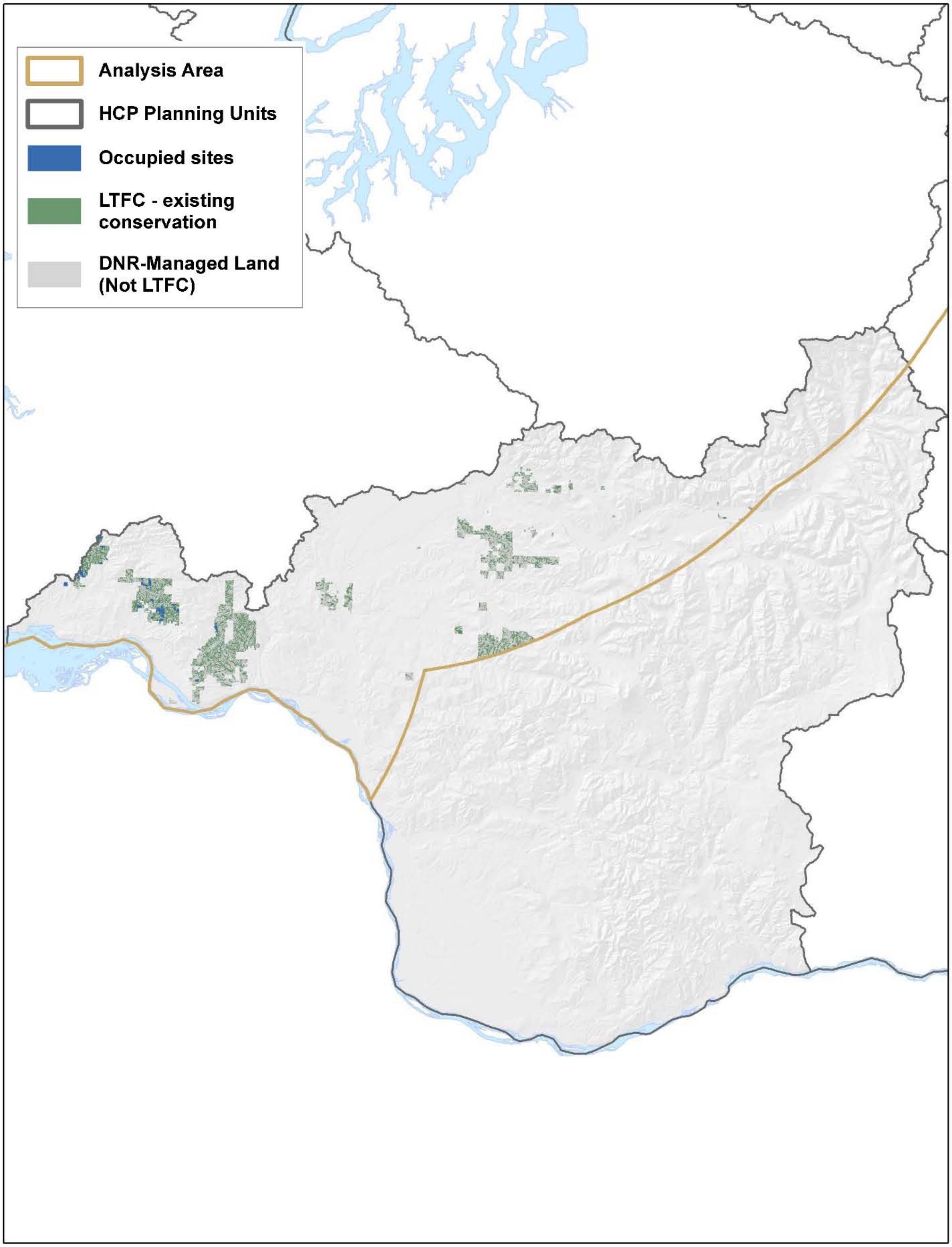




Alternative B: South Puget planning unit (includes small portion of Yakima Planning unit)

Alternative B: Columbia planning unit



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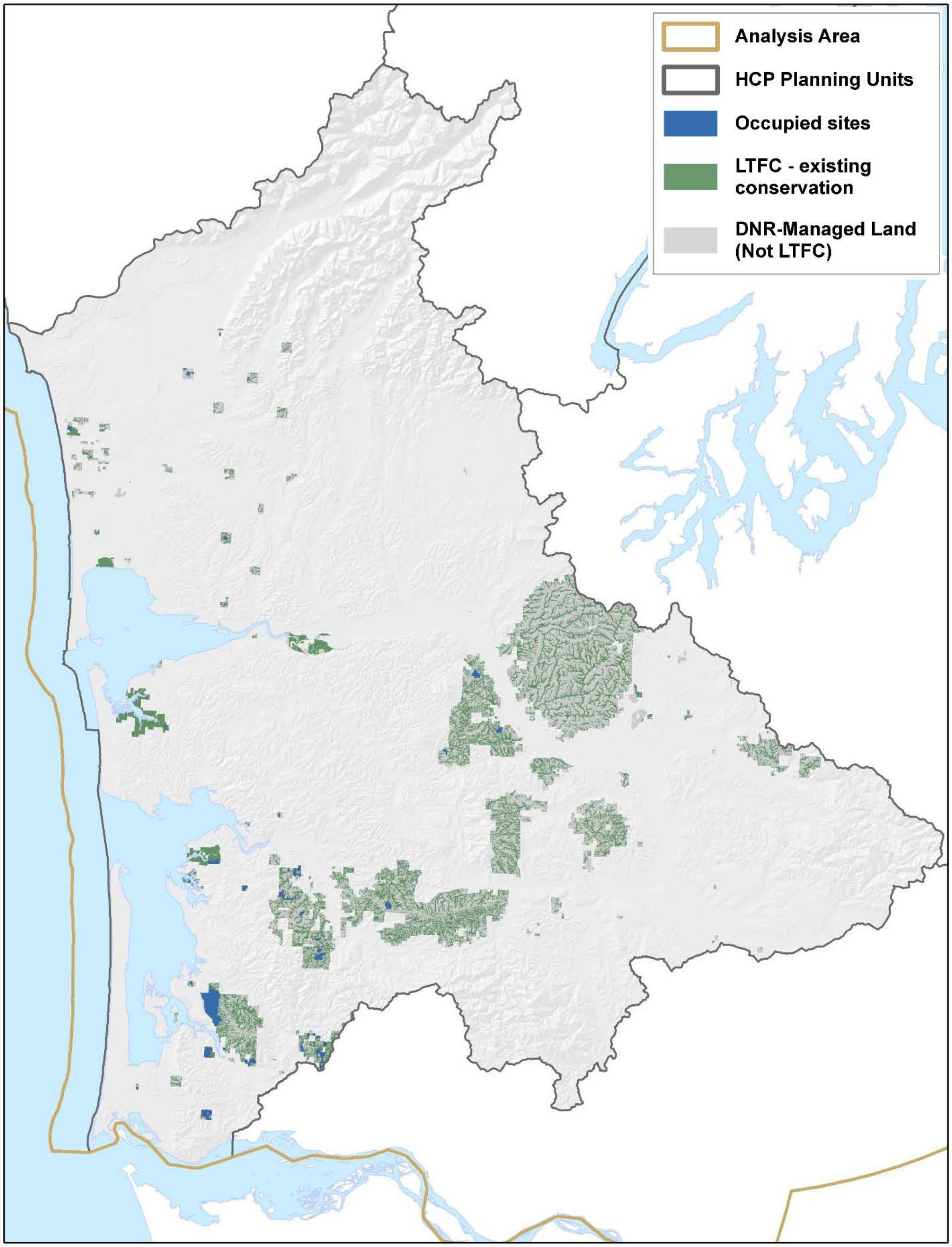
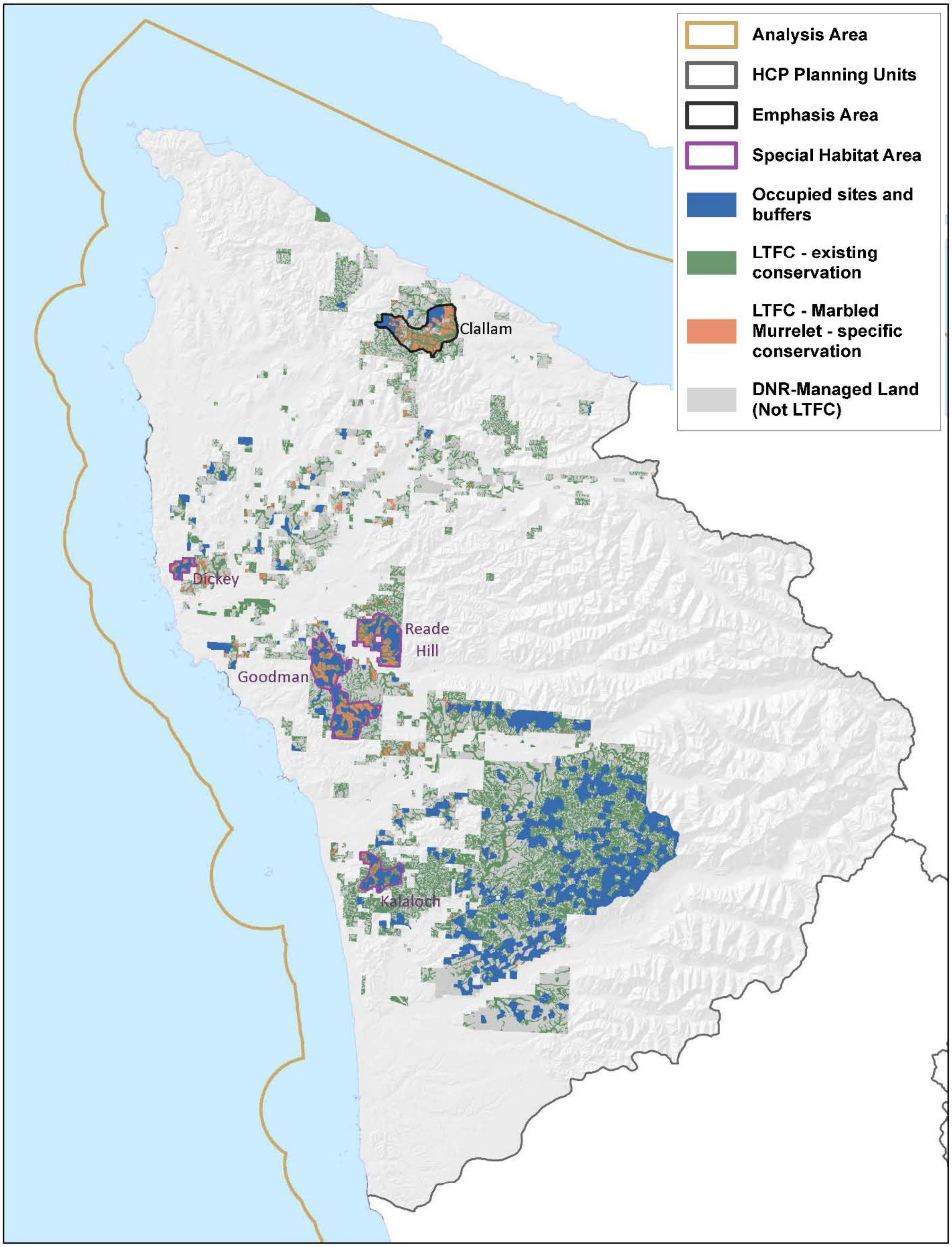
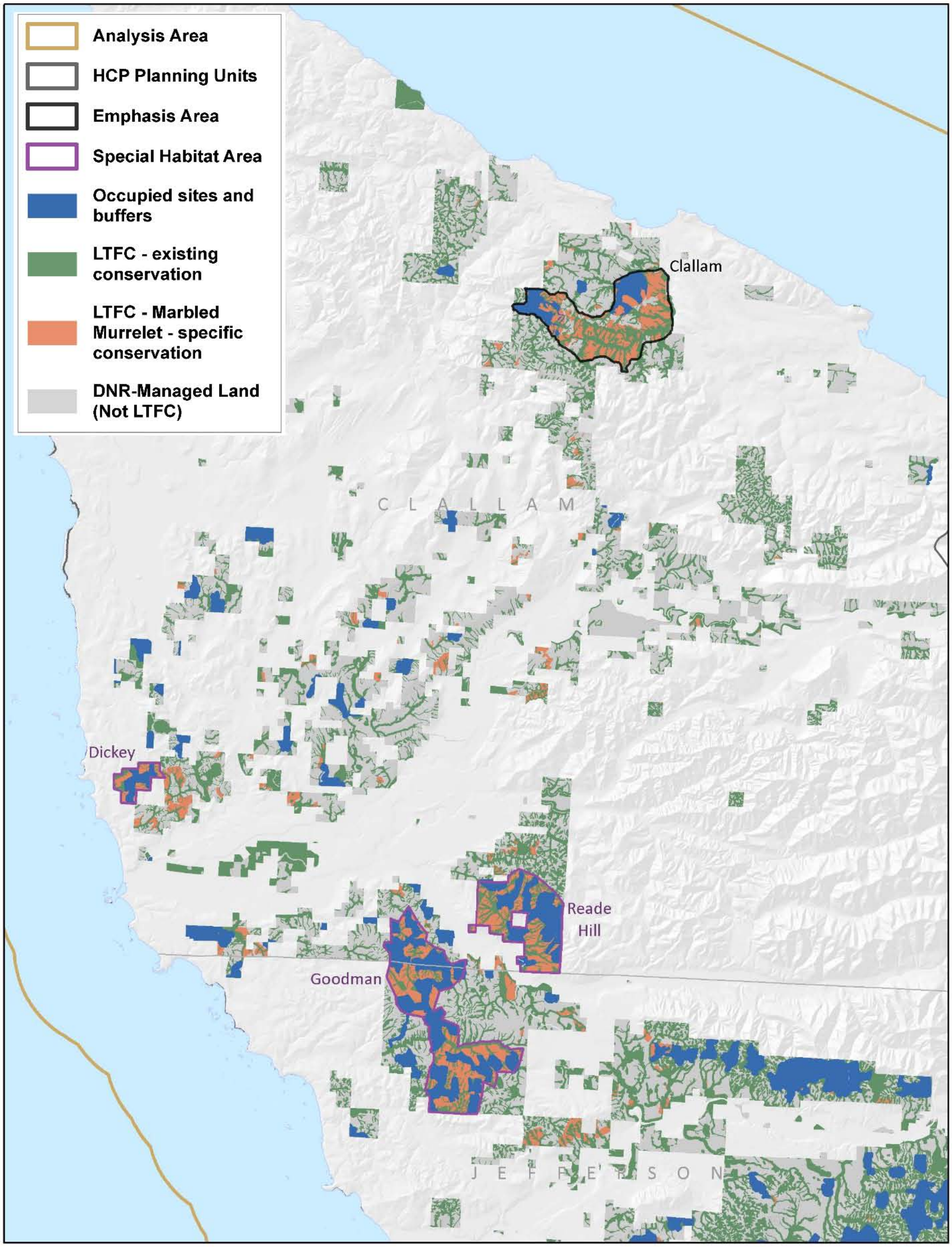


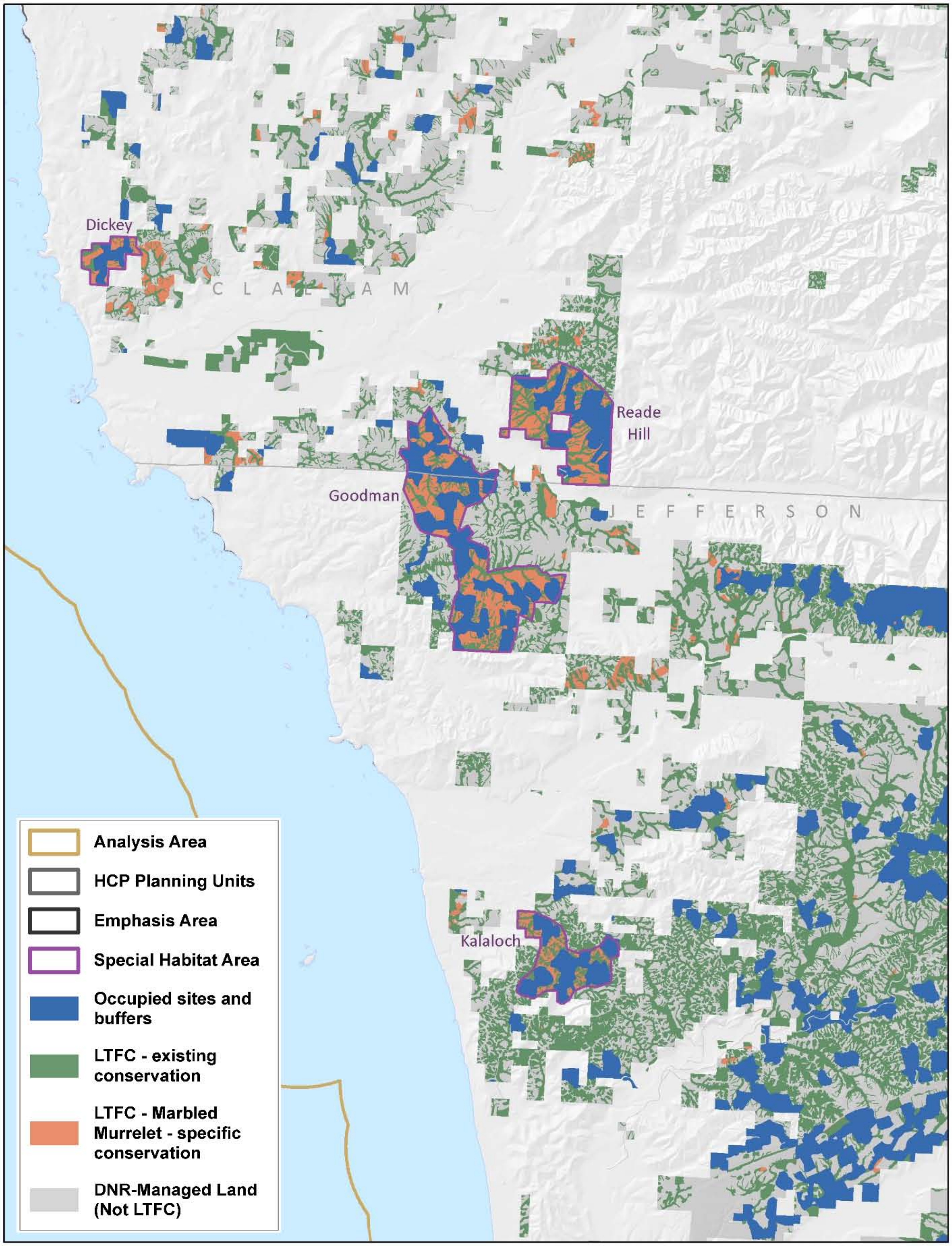
Alternative C: OESF planning unit



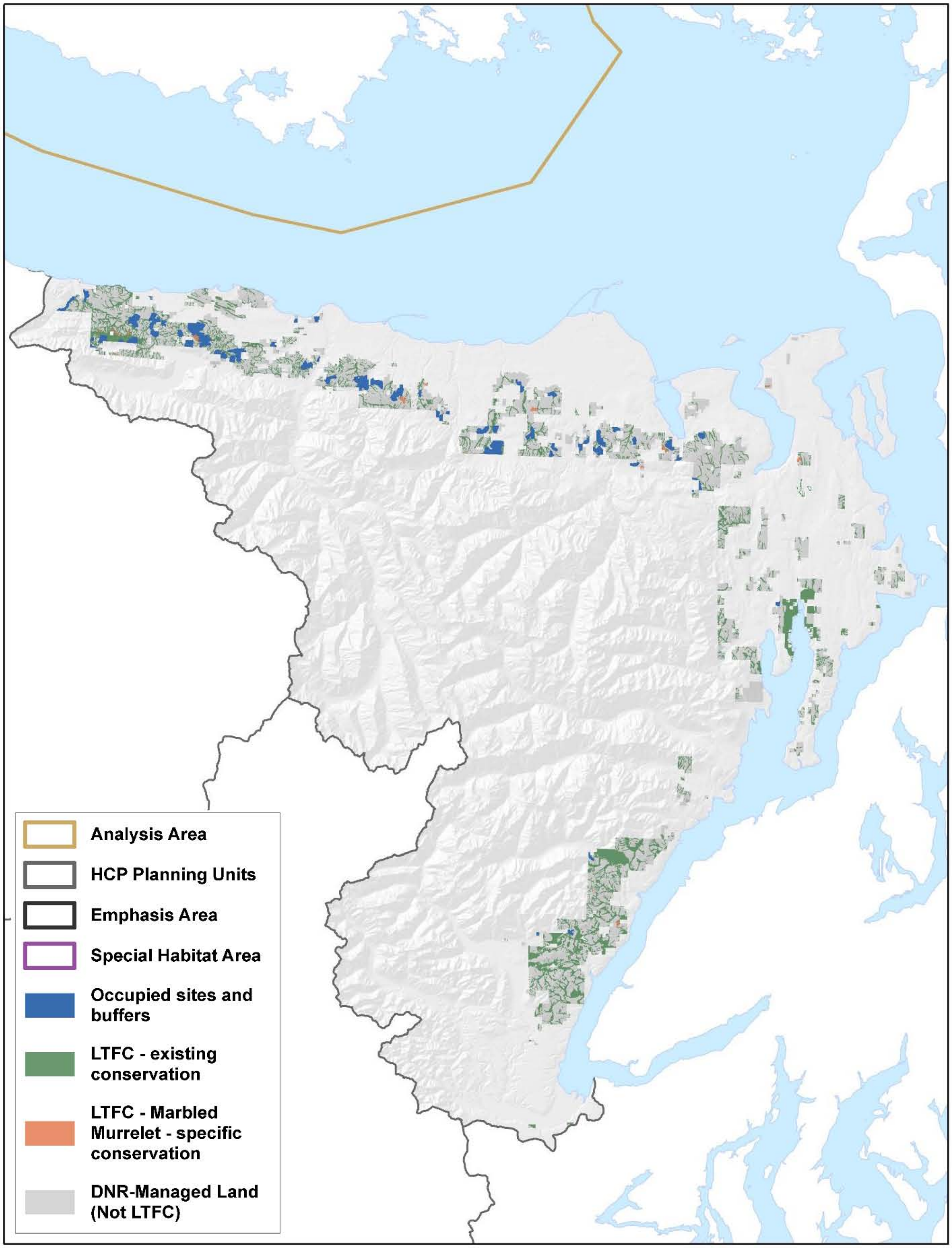
Alternative C: Emphasis Areas and Special Habitat Areas in OESF planning unit (north)



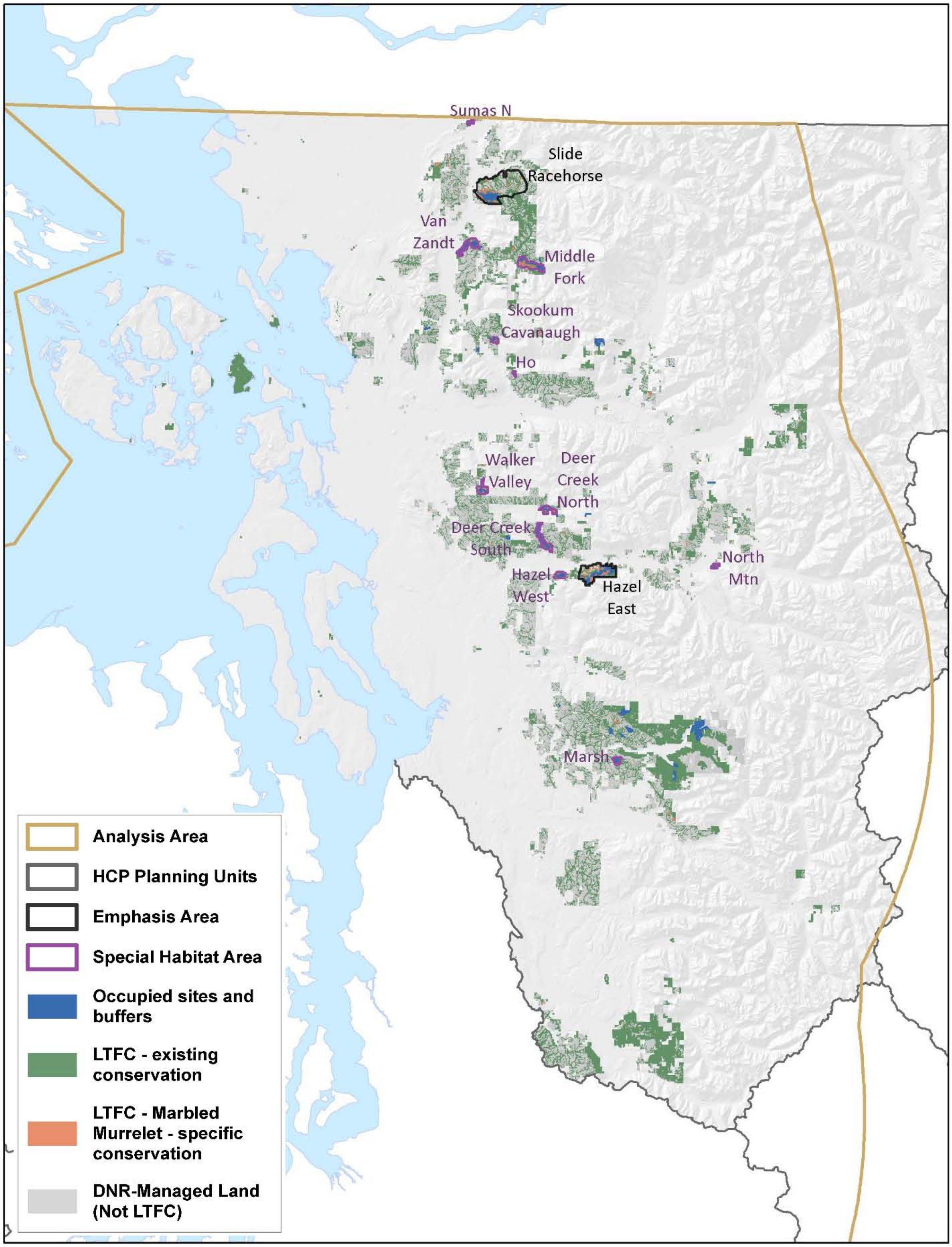
Alternative C: Emphasis Areas and Special Habitat Areas in OESF planning unit (south)



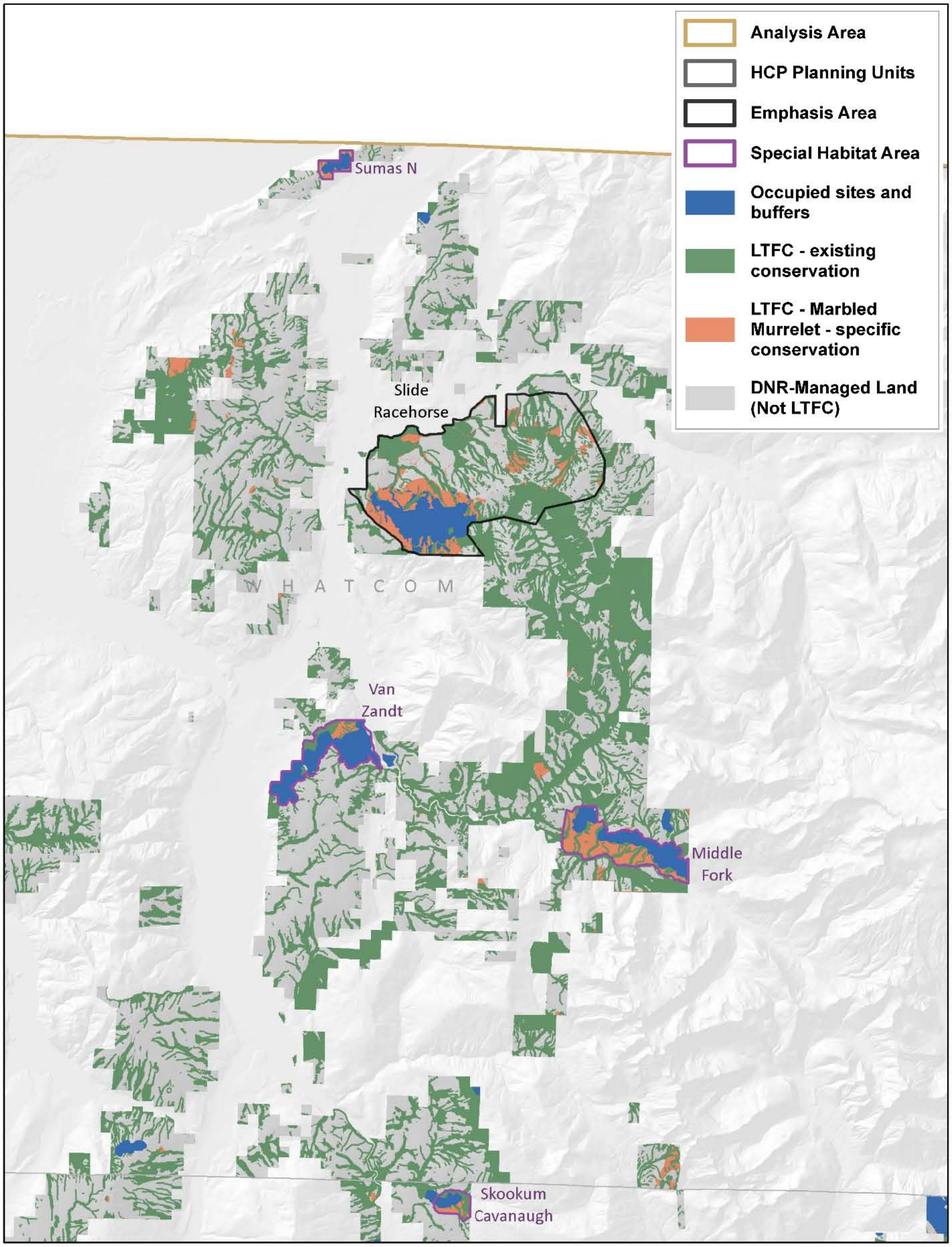
Alternative C: Straits planning unit



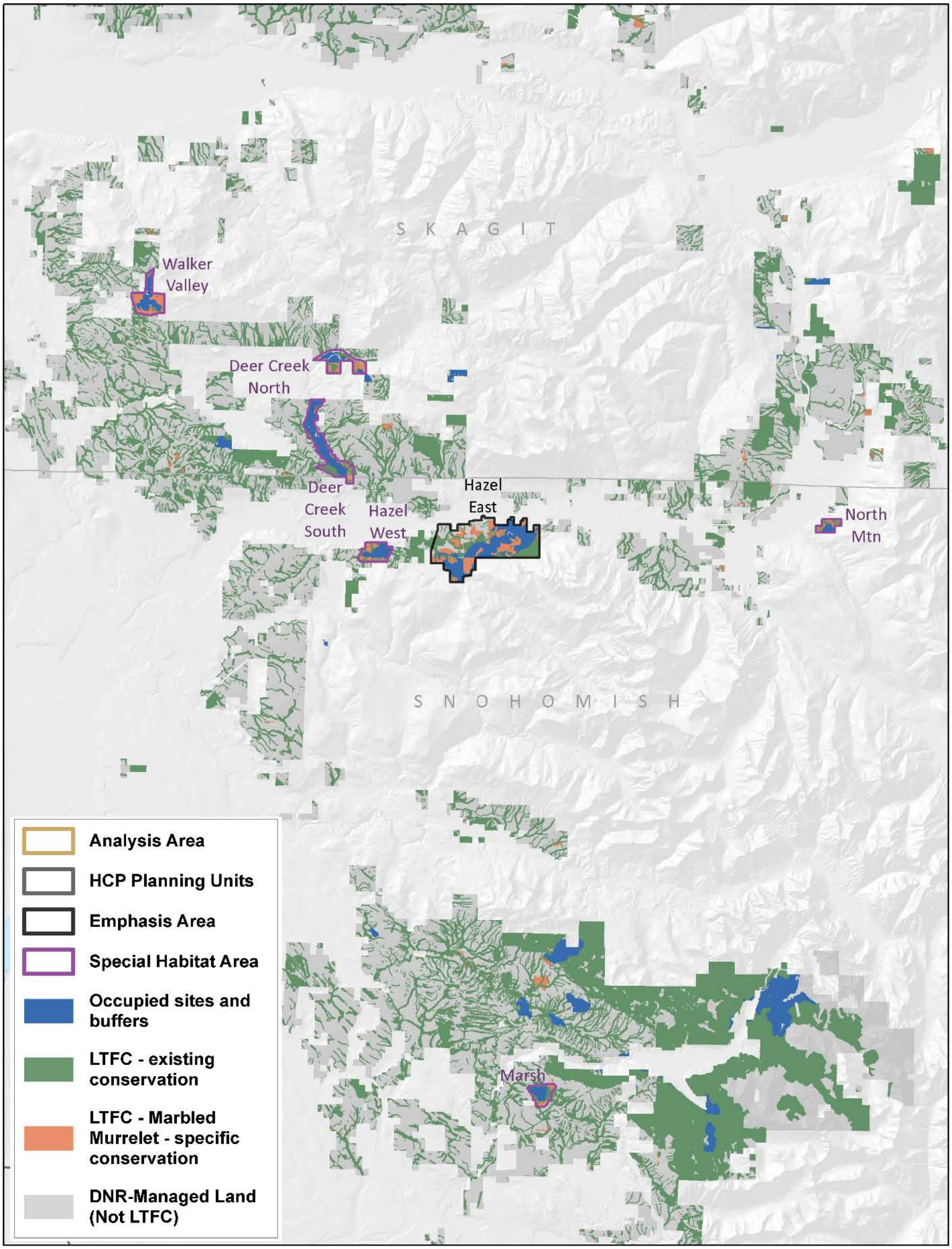
Alternative C: North Puget planning unit



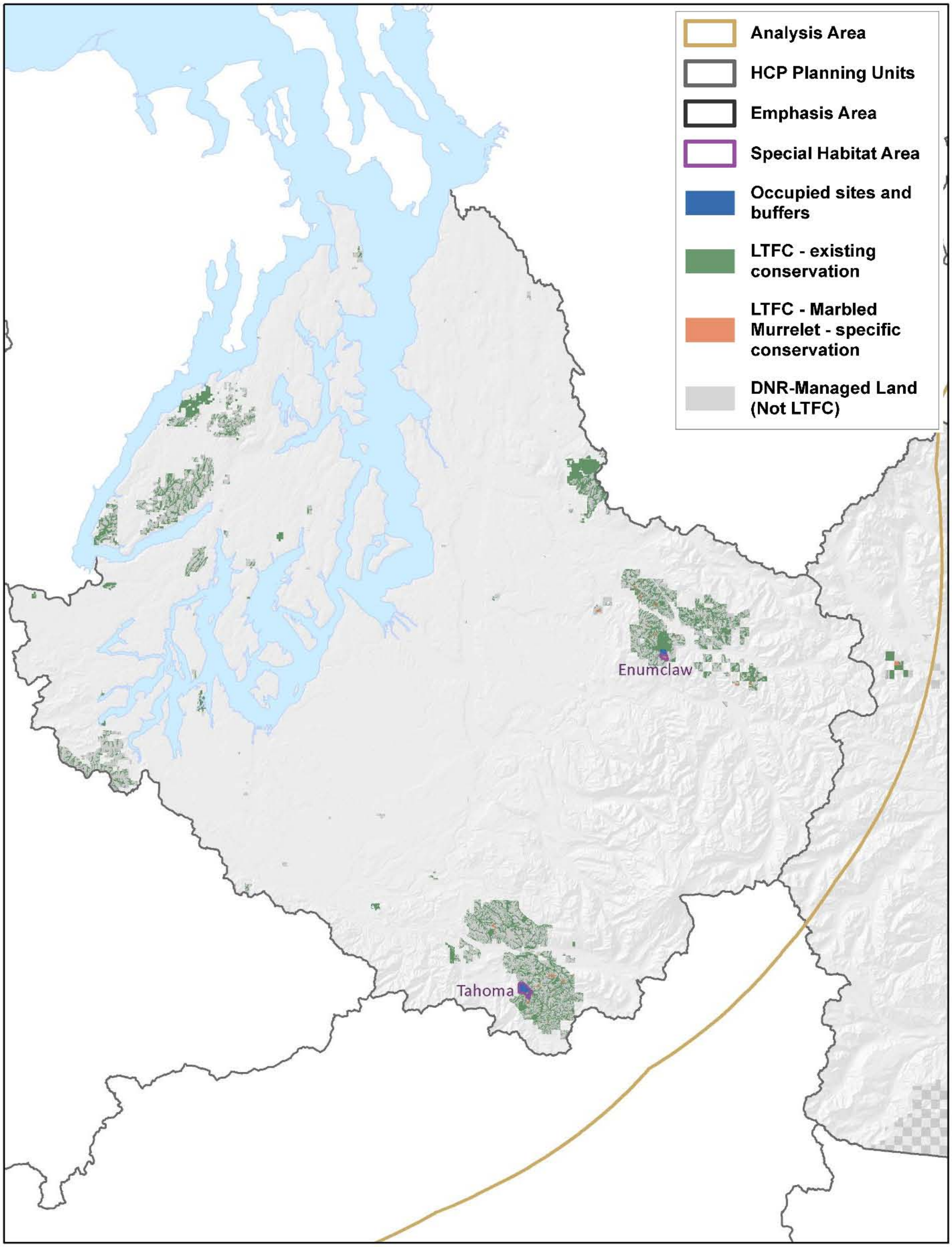
Alternative C: Emphasis Areas and Special Habitat Areas, North Puget planning unit (north)



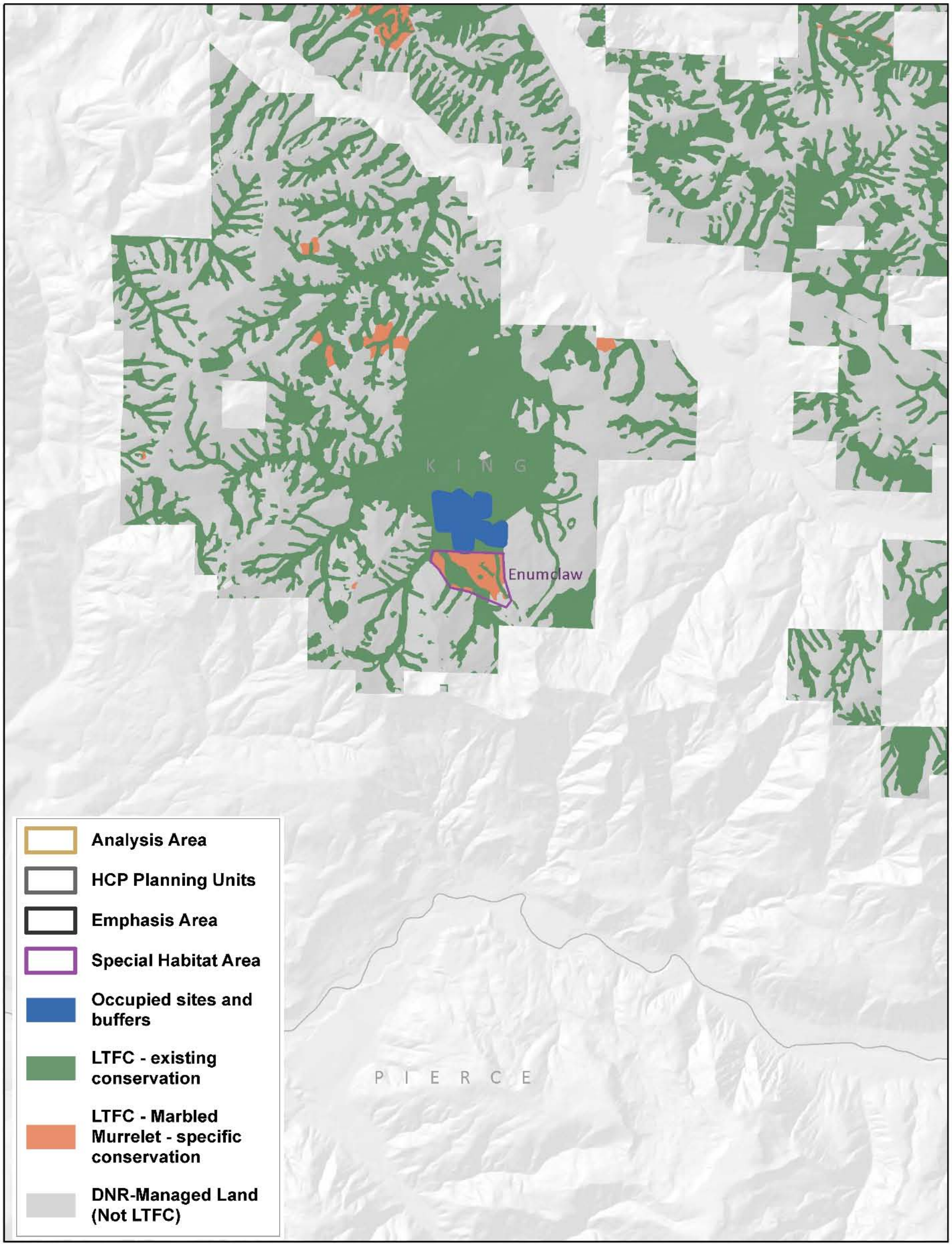
Alternative C: Emphasis Areas and Special Habitat Areas, North Puget planning unit (south)



Alternative C: South Puget planning unit (includes small portion of Yakima planning unit)



Alternative C: Emphasis Areas and Special Habitat Areas, South Puget planning unit (north)



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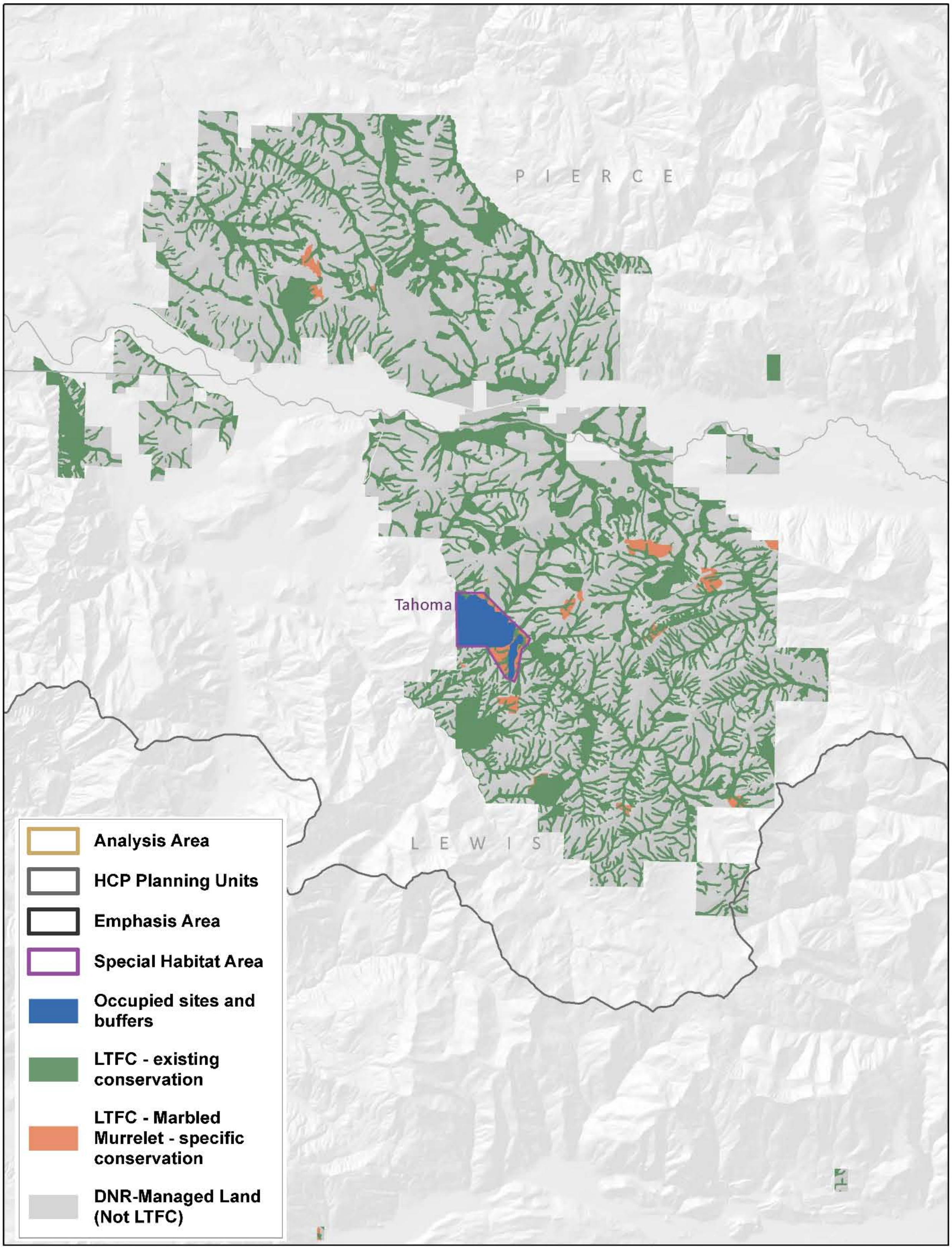
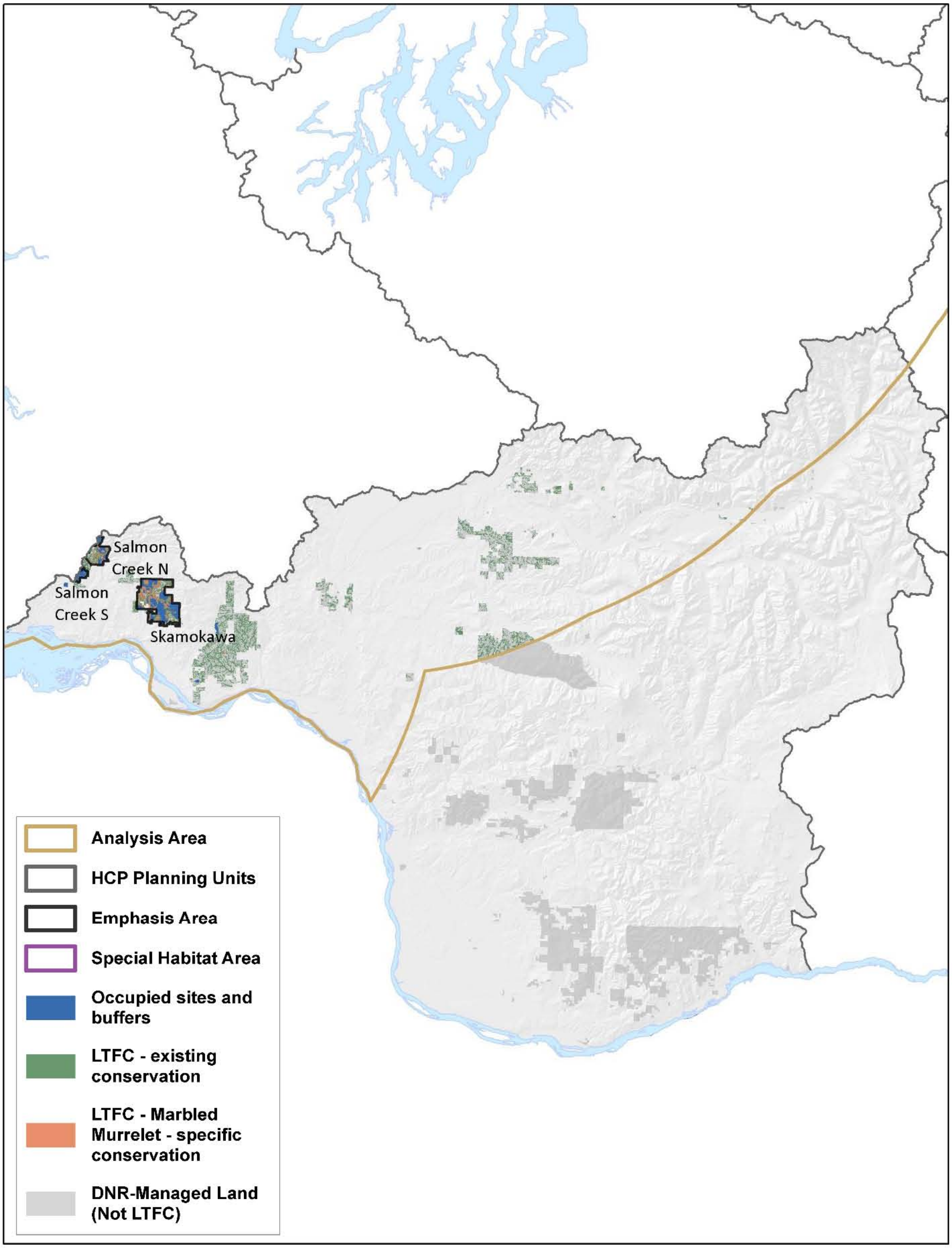


Alternative C: Columbia planning unit



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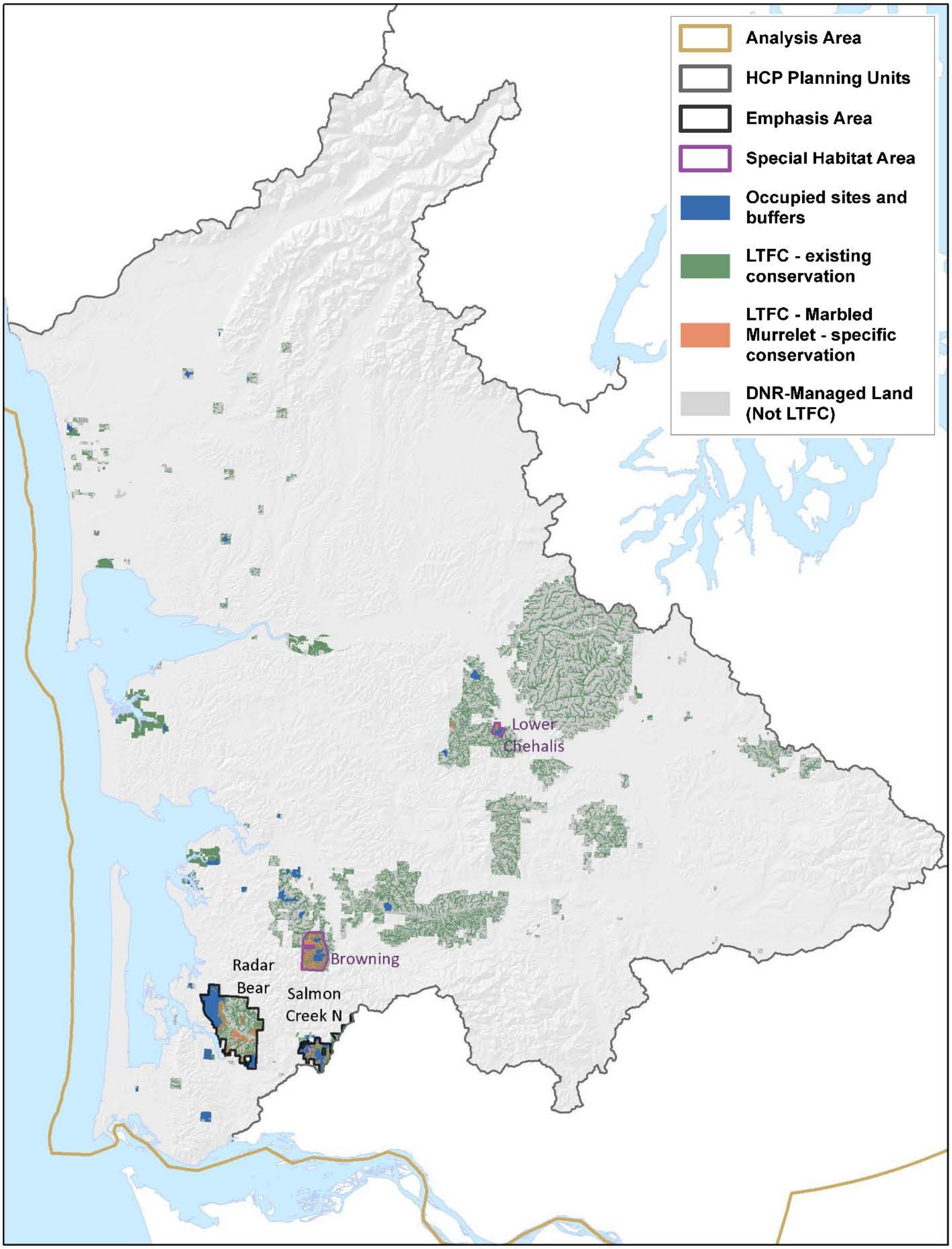
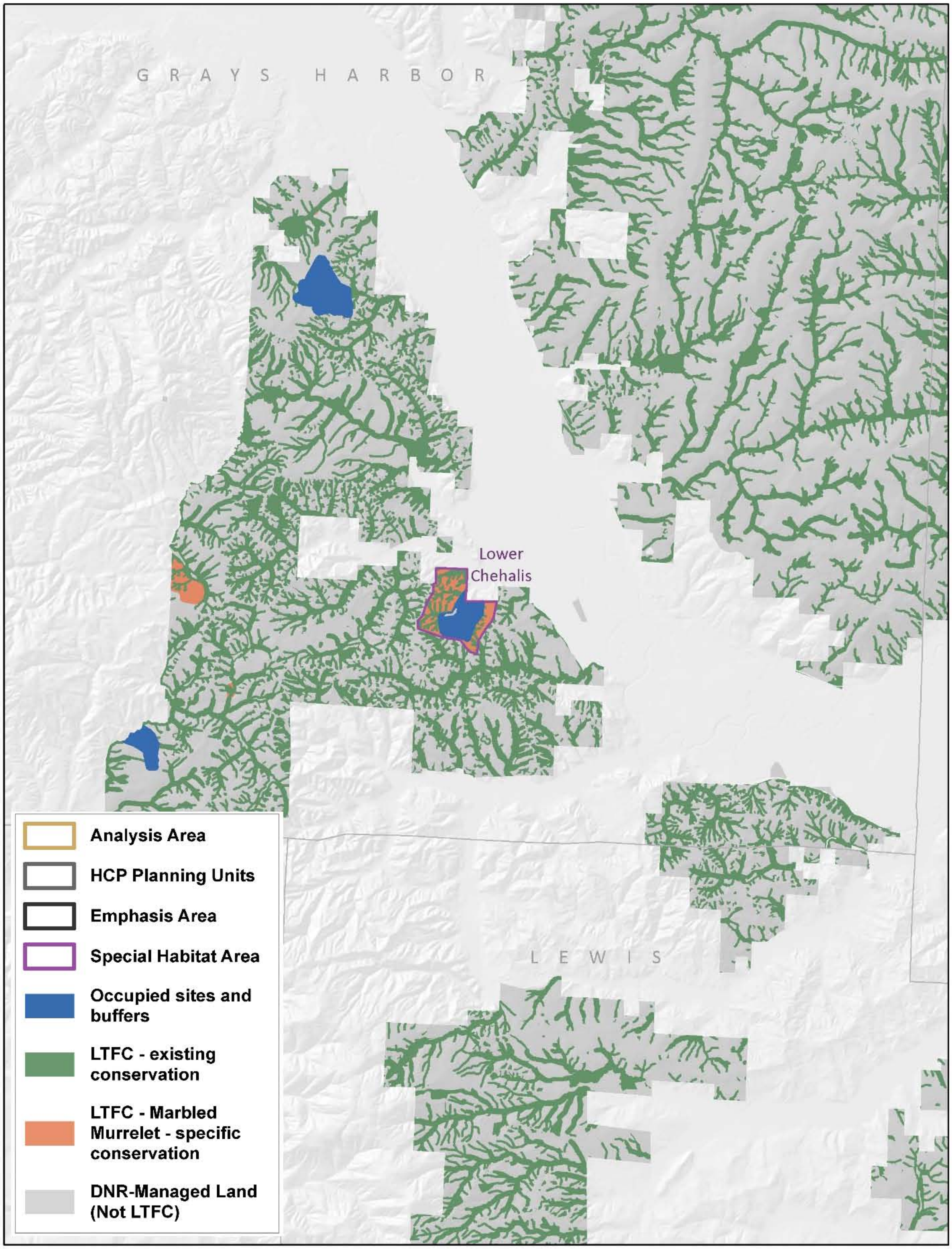
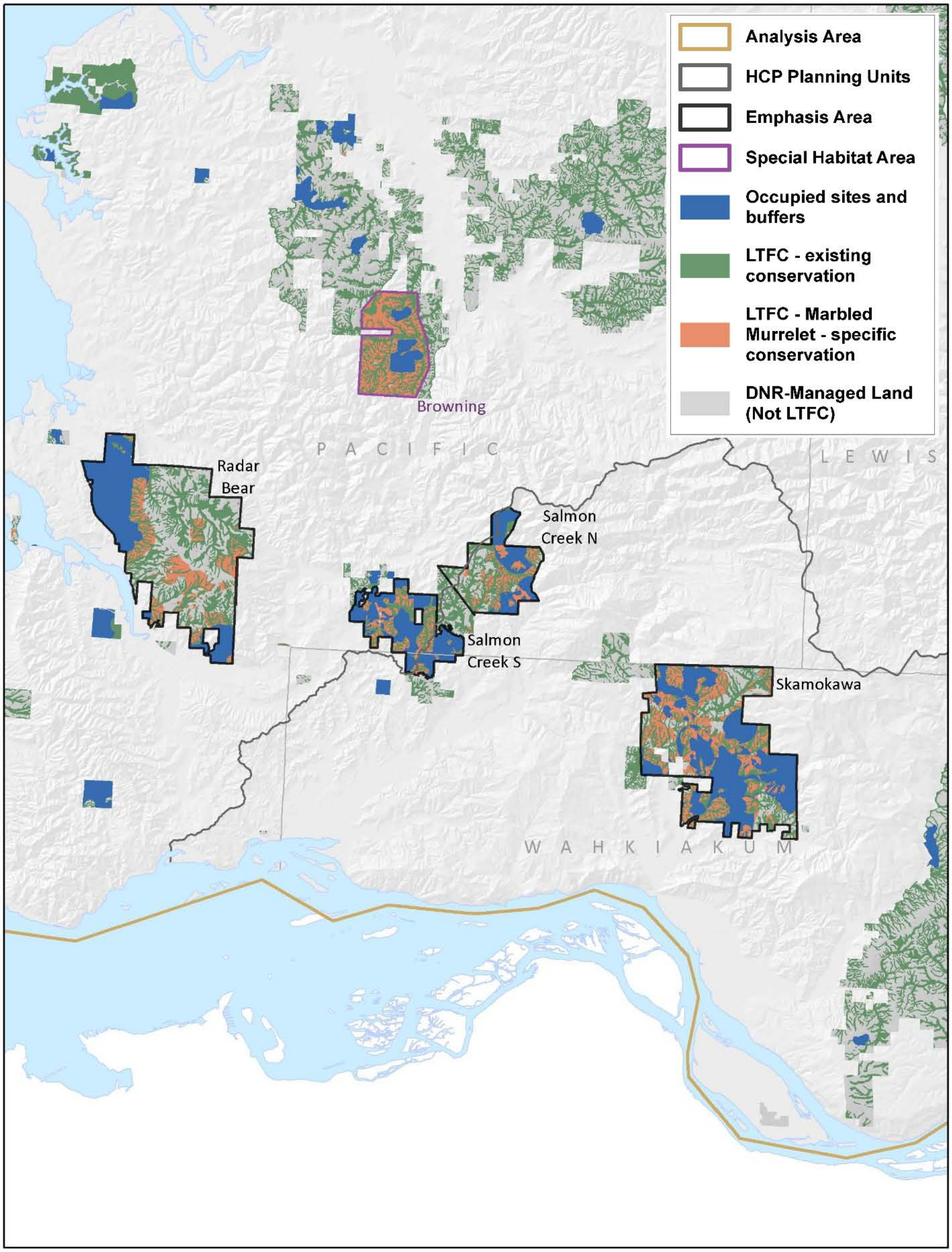


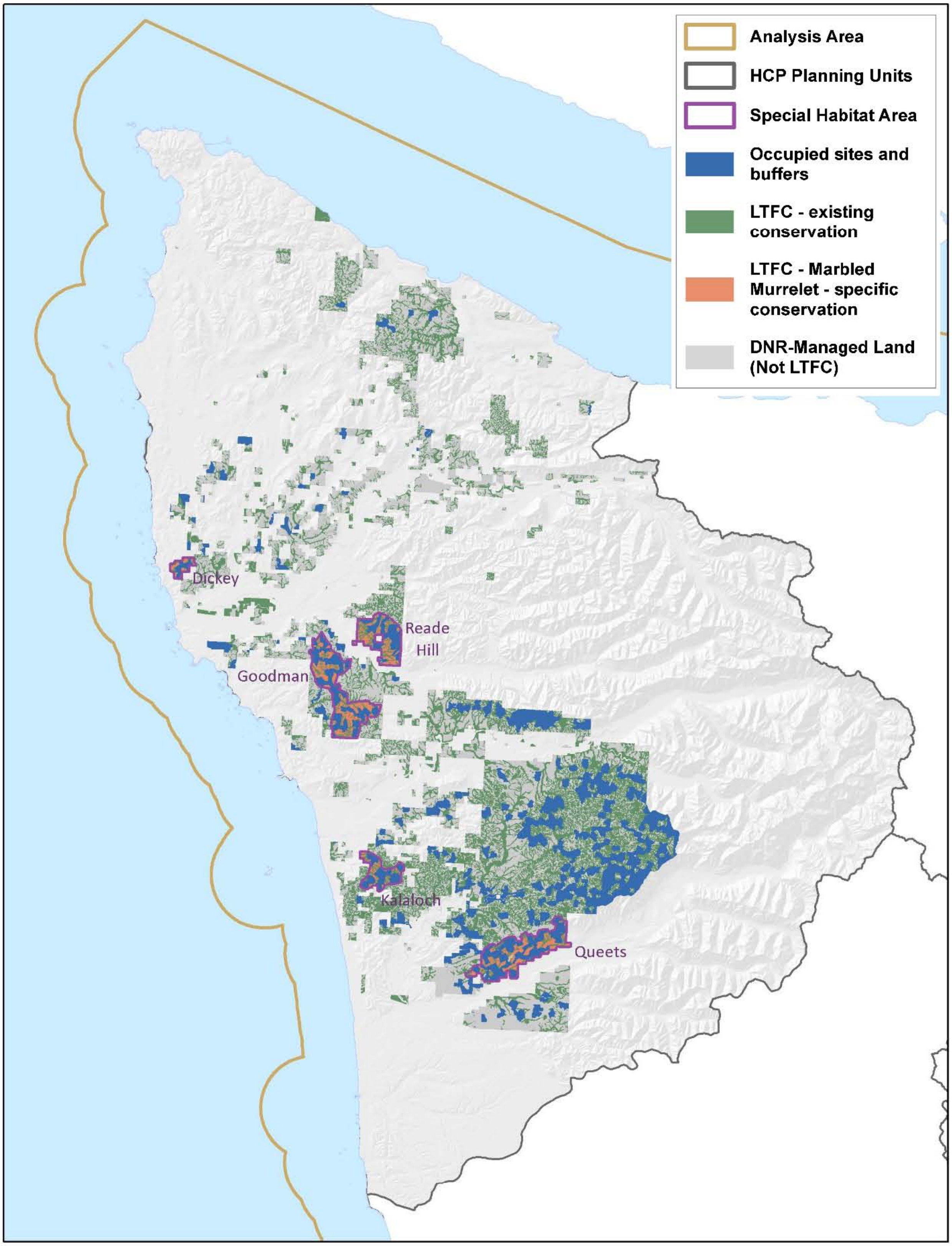
Alternative C: Emphasis Areas and Special Habitat Areas, South Coast planning unit (north)



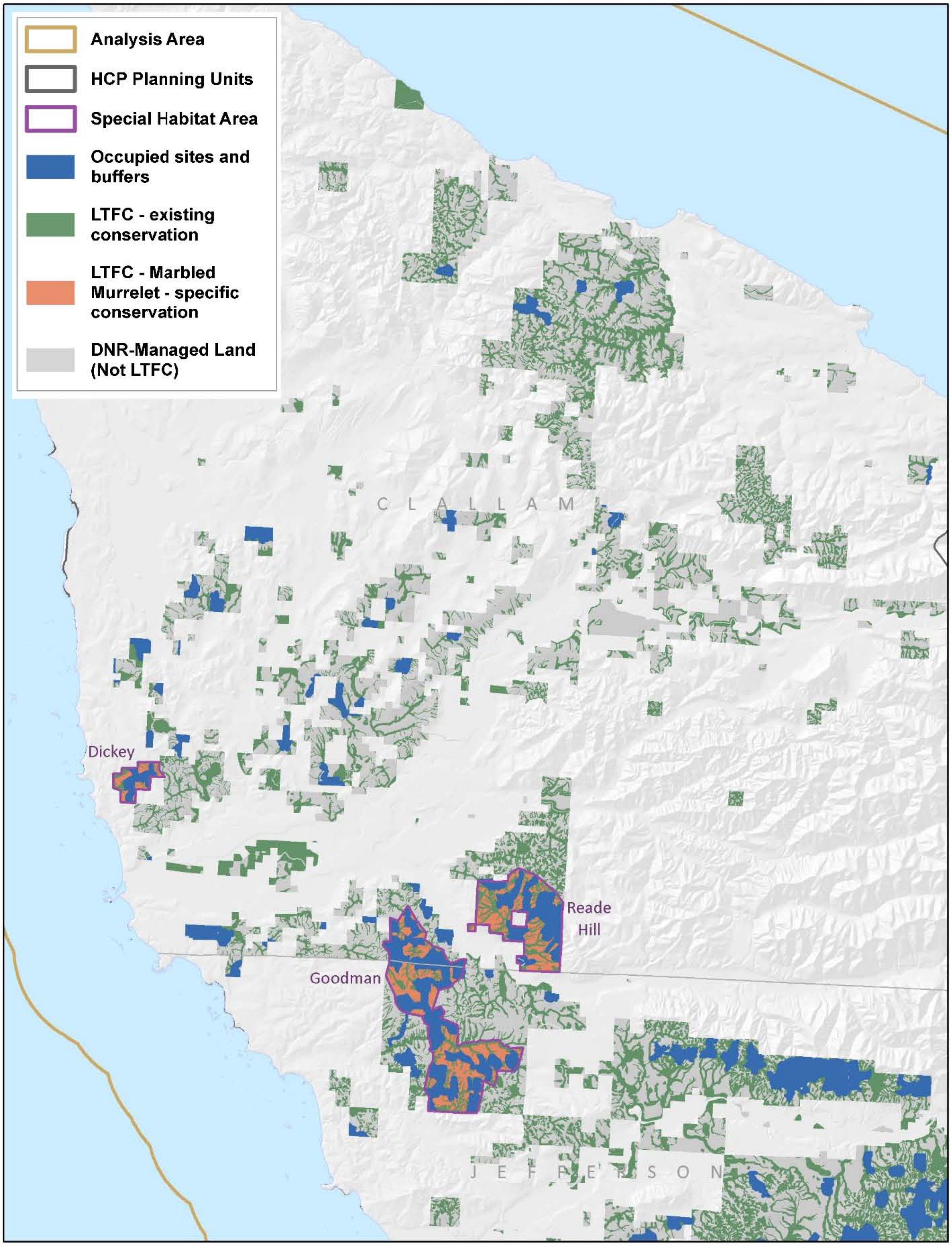
Alternative C: Emphasis Areas and Special Habitat Areas, South Coast (south) and Columbia planning unit (north)



Alternative D: OESF planning unit



Alternative D: Special Habitat Areas, OESF planning unit (north)



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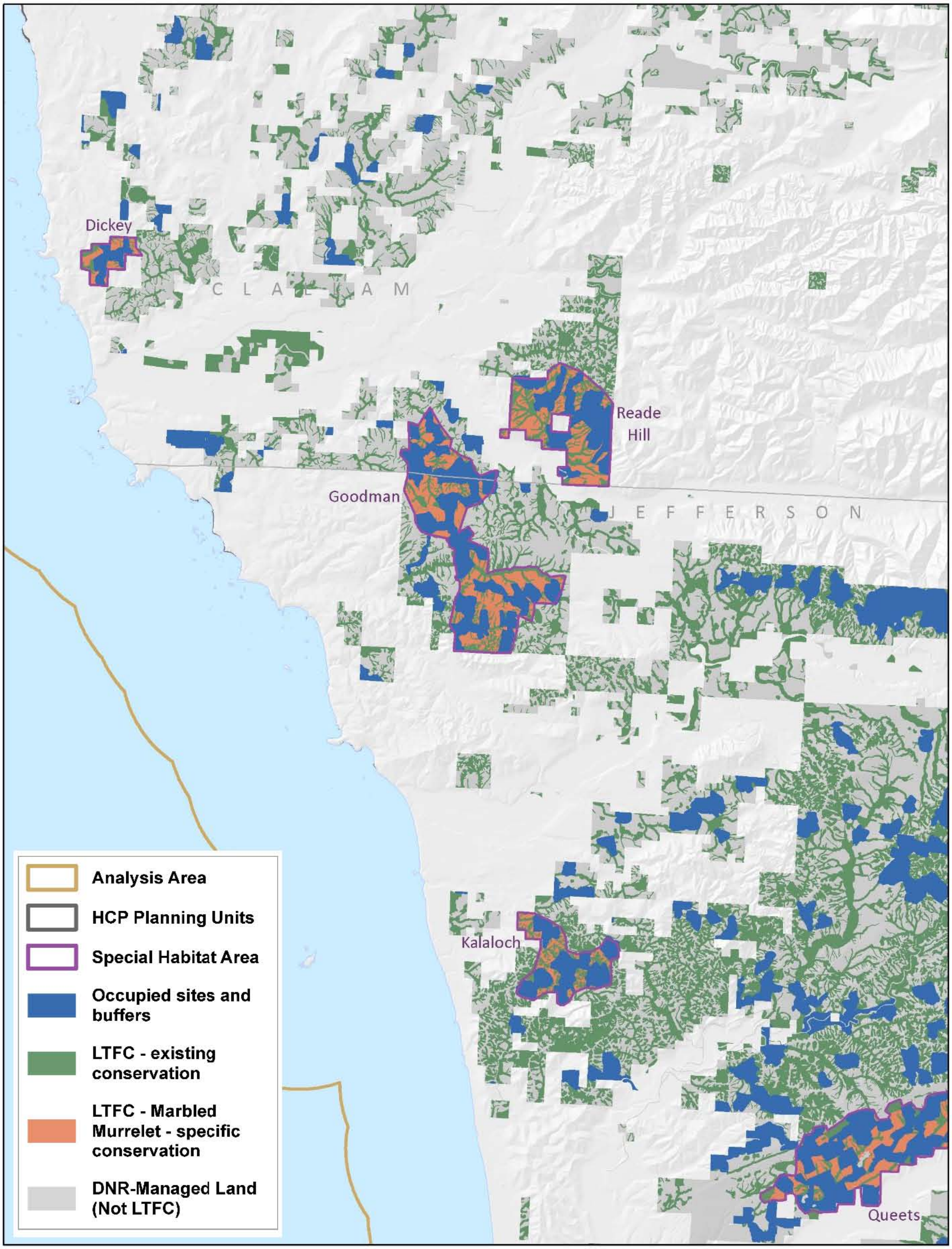
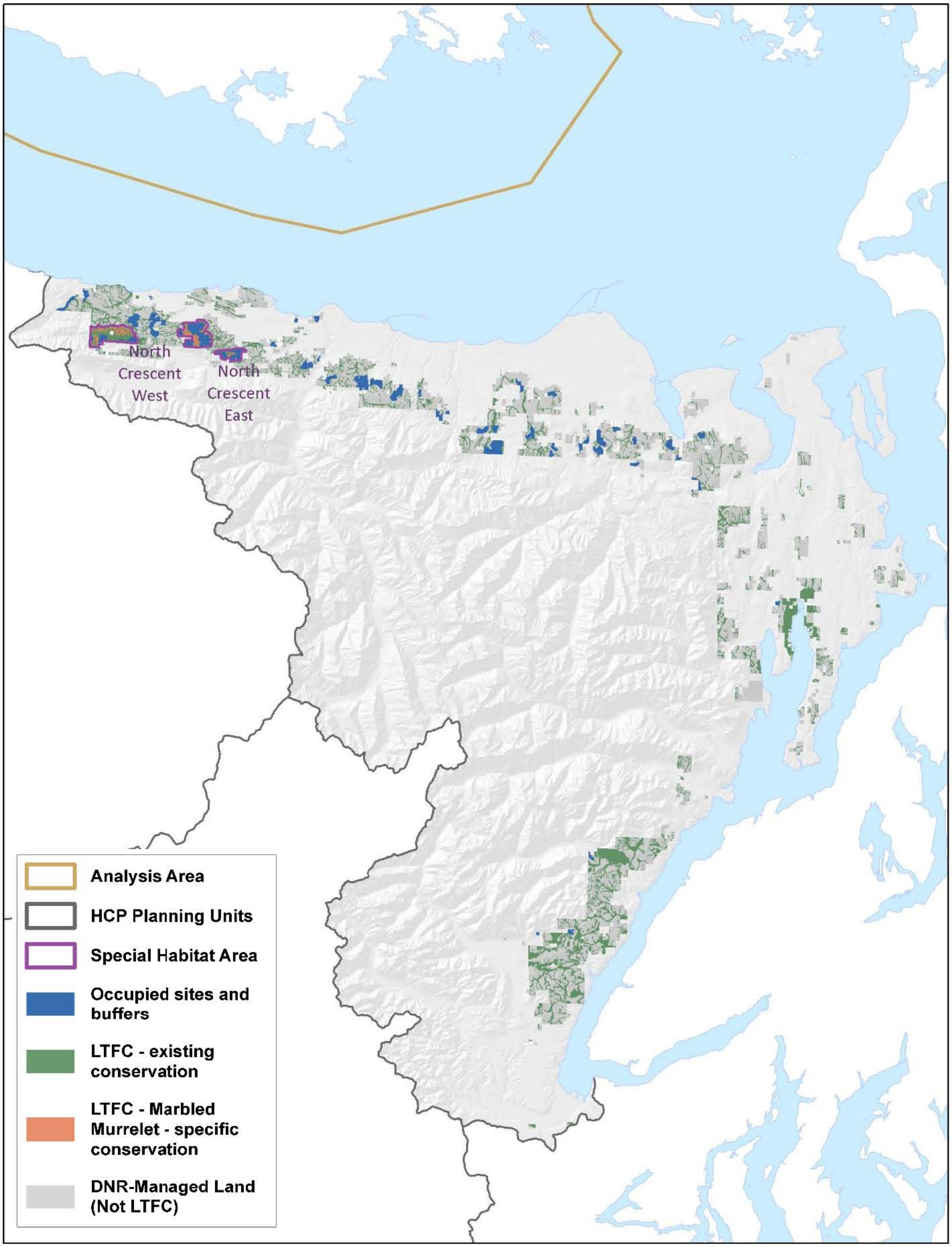


Alternative D: Straits planning unit



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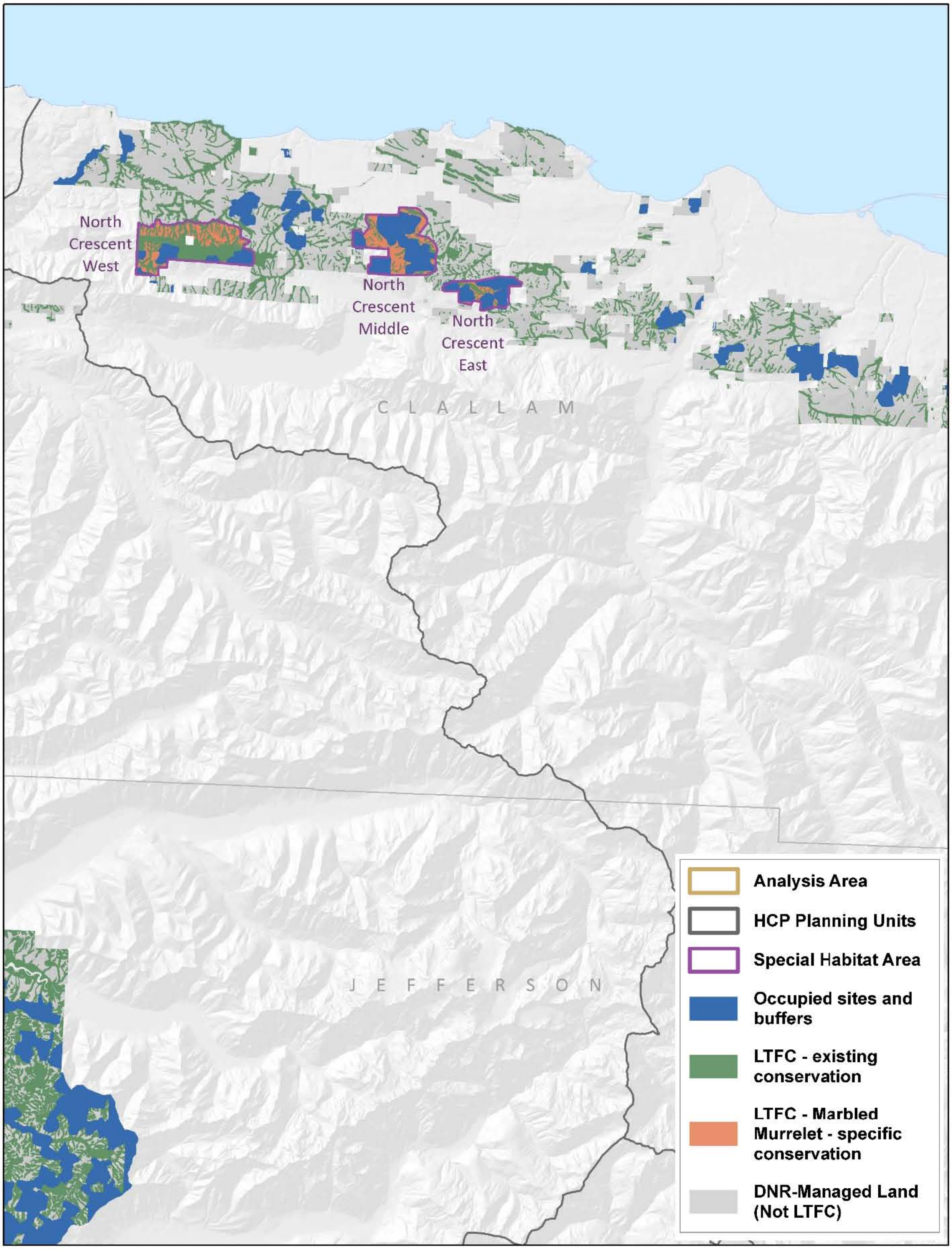

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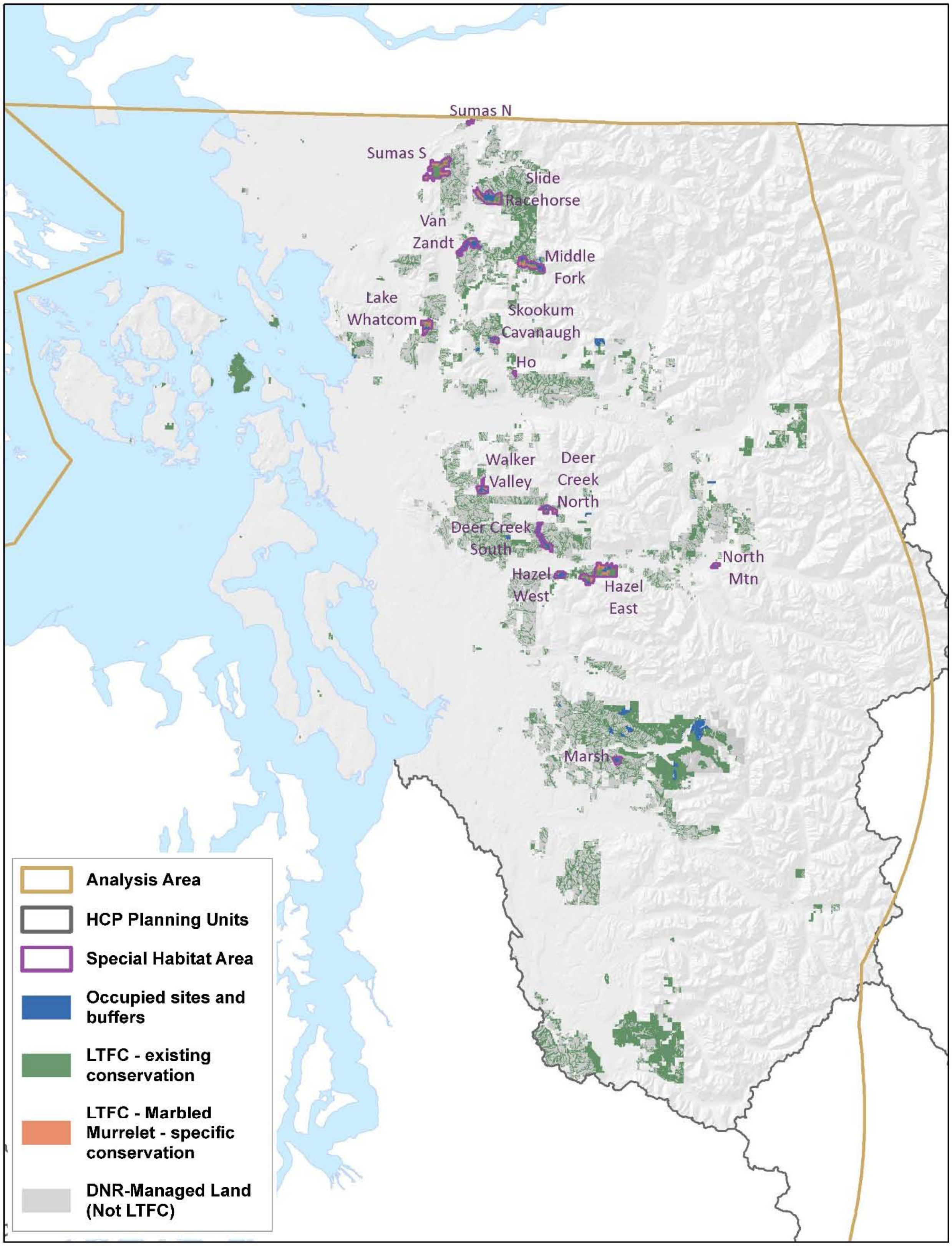

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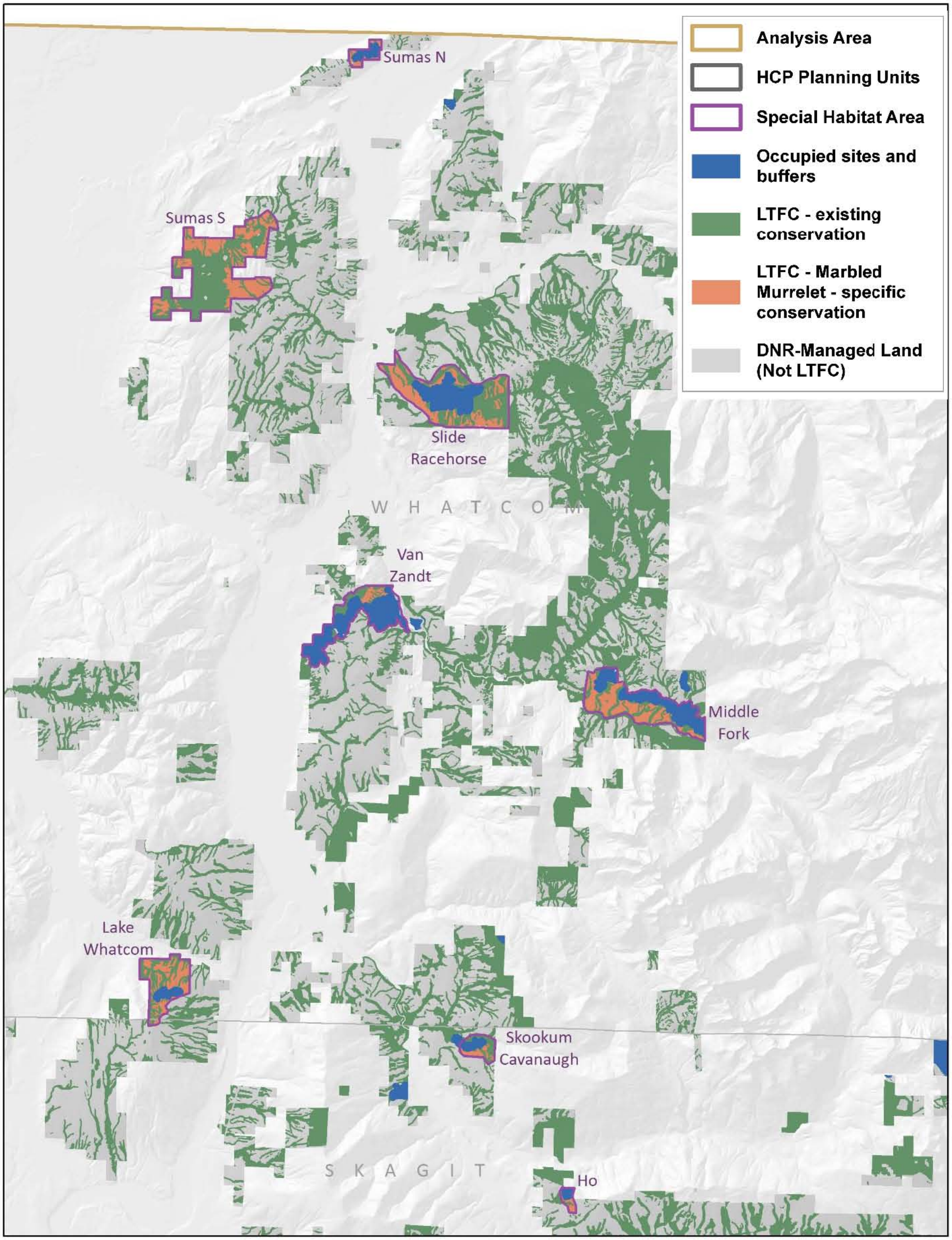
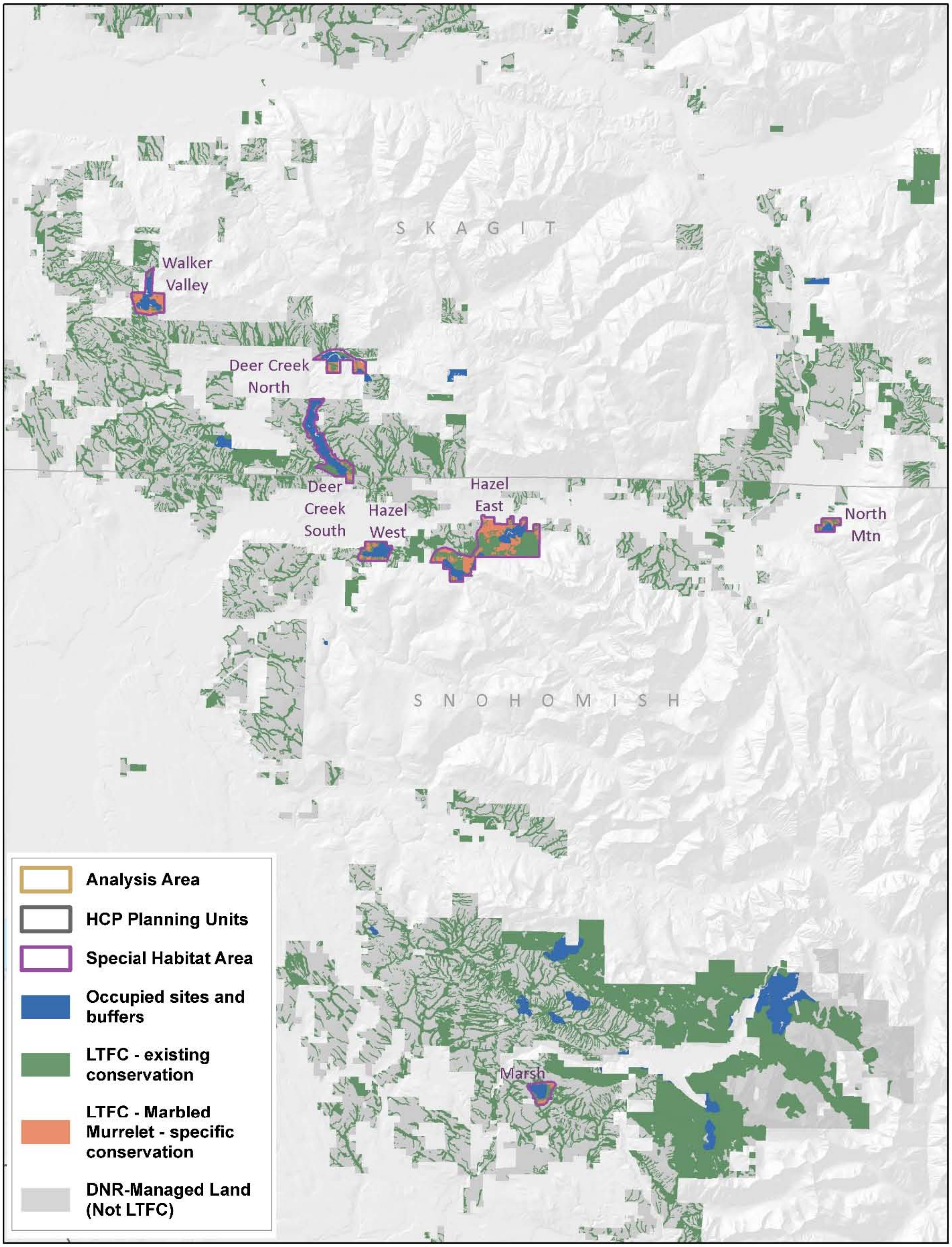
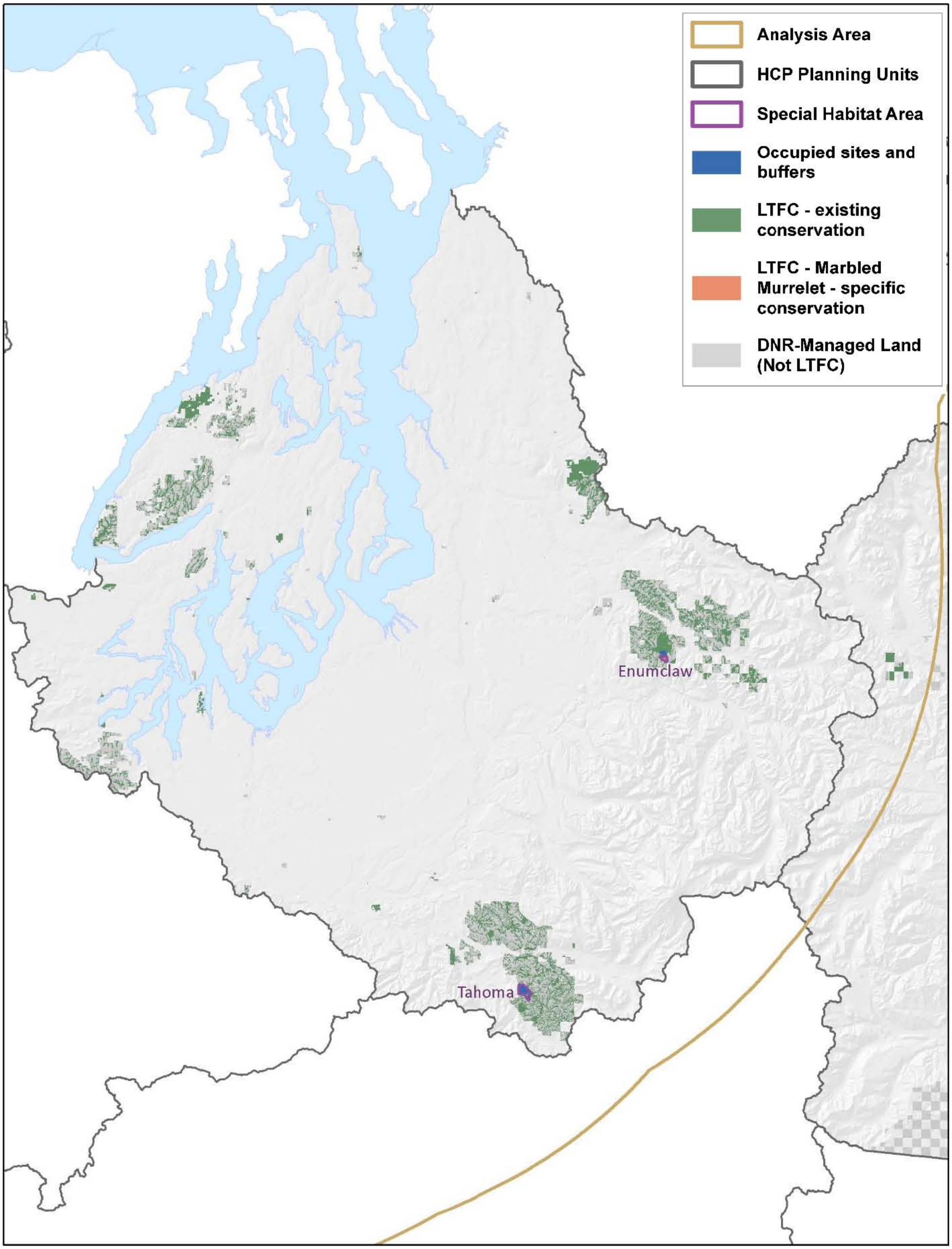


Alternative D: Special Habitat Areas, North Puget planning unit (south)



Alternative D: South Puget planning unit (includes small portion of Yakima planning unit)



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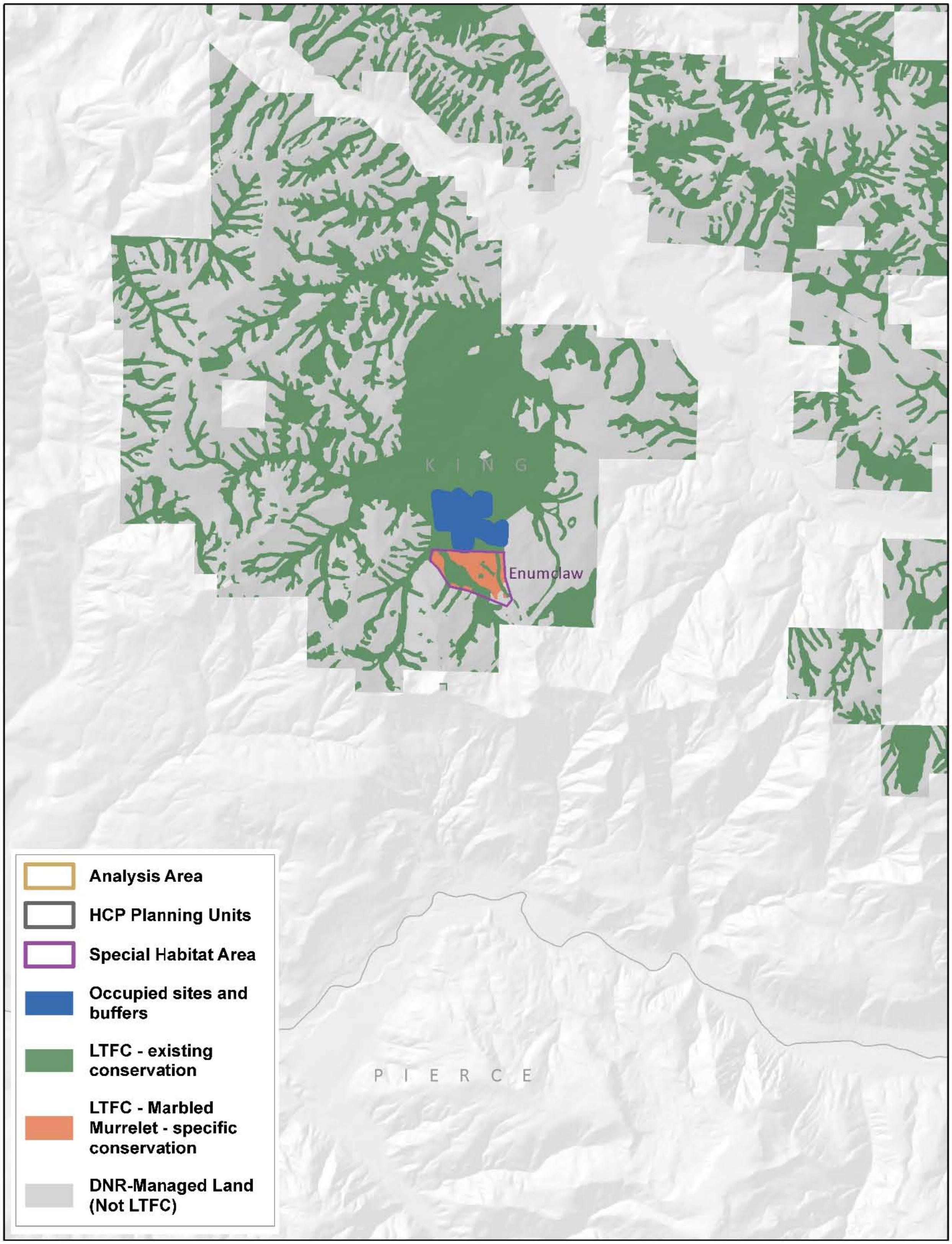

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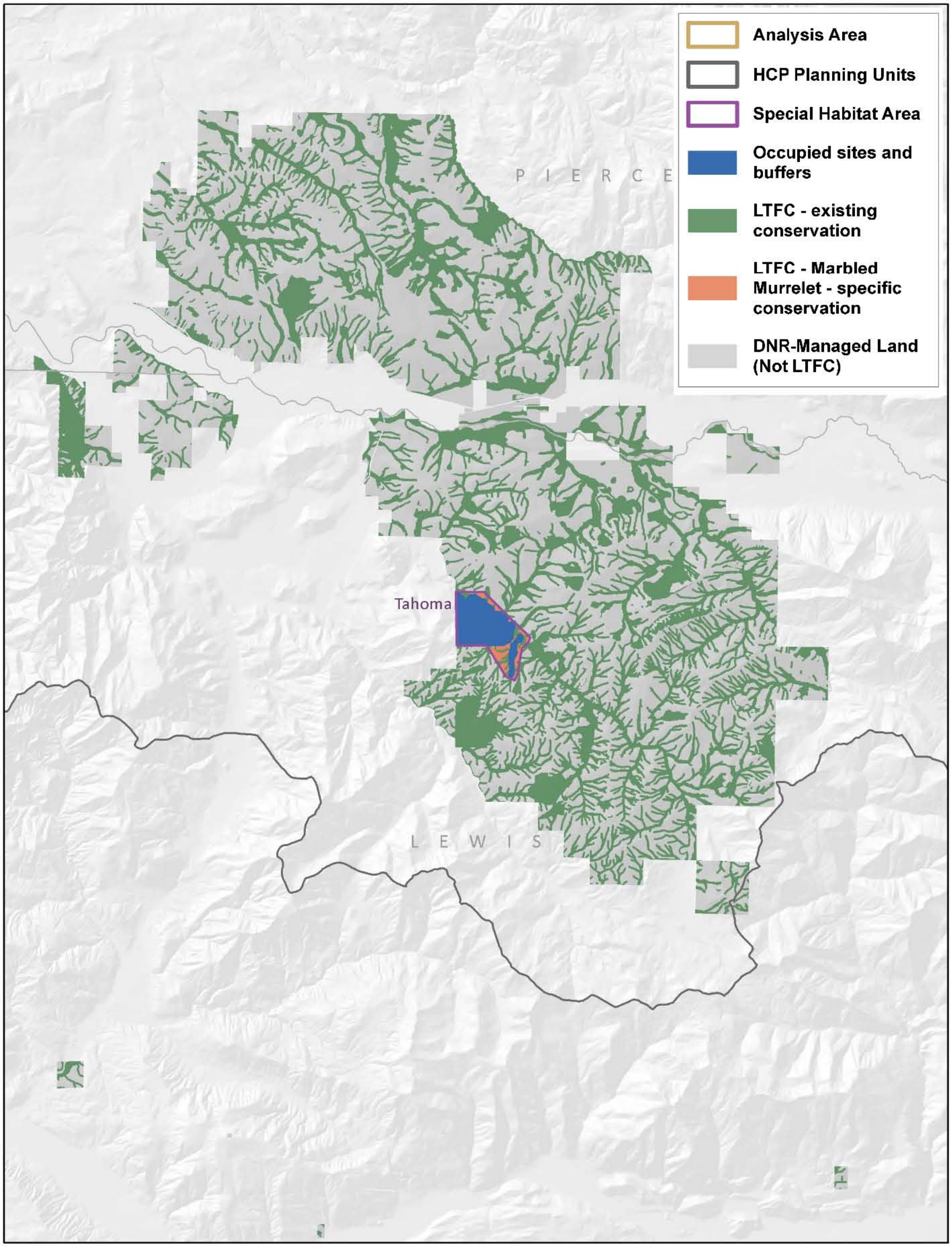
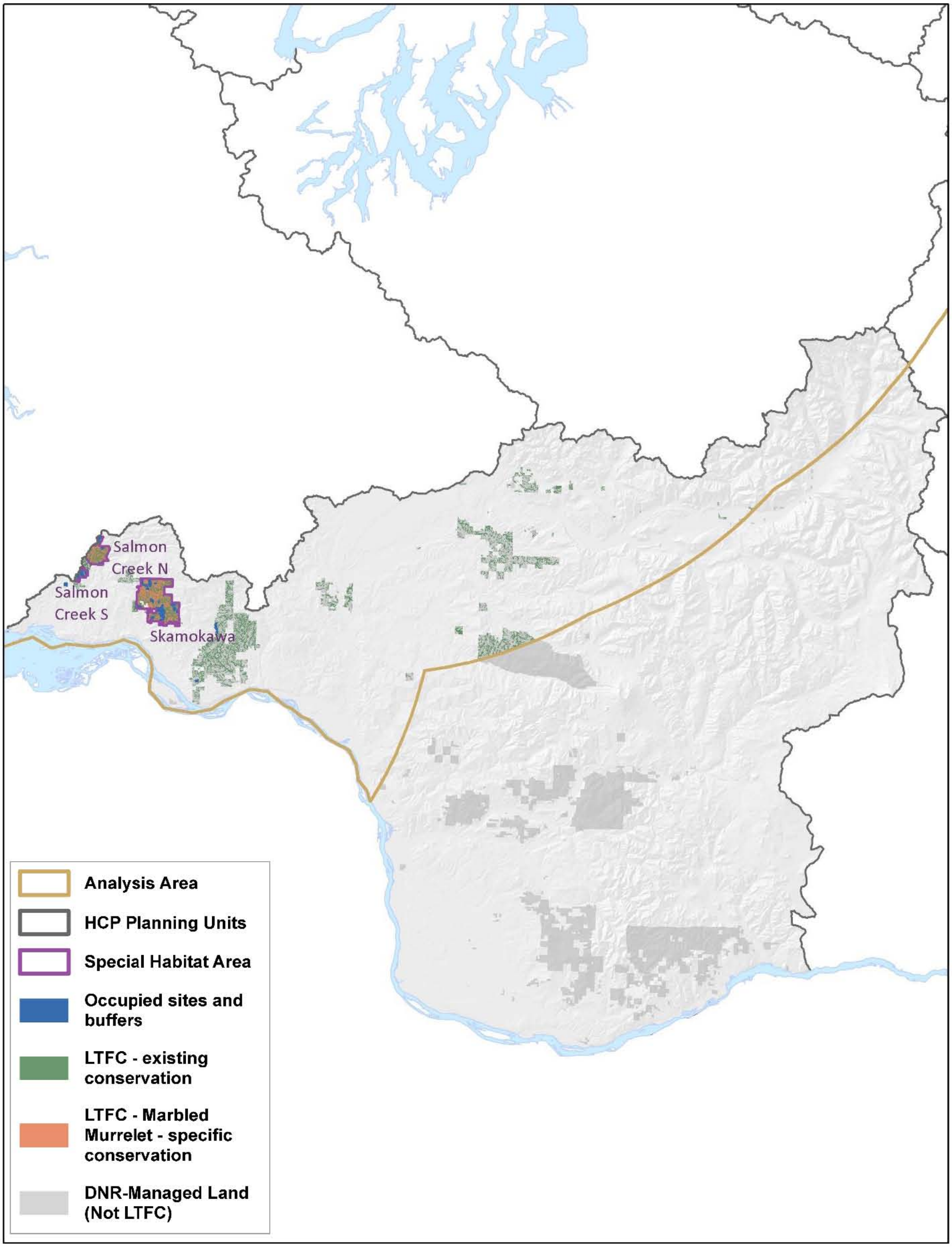
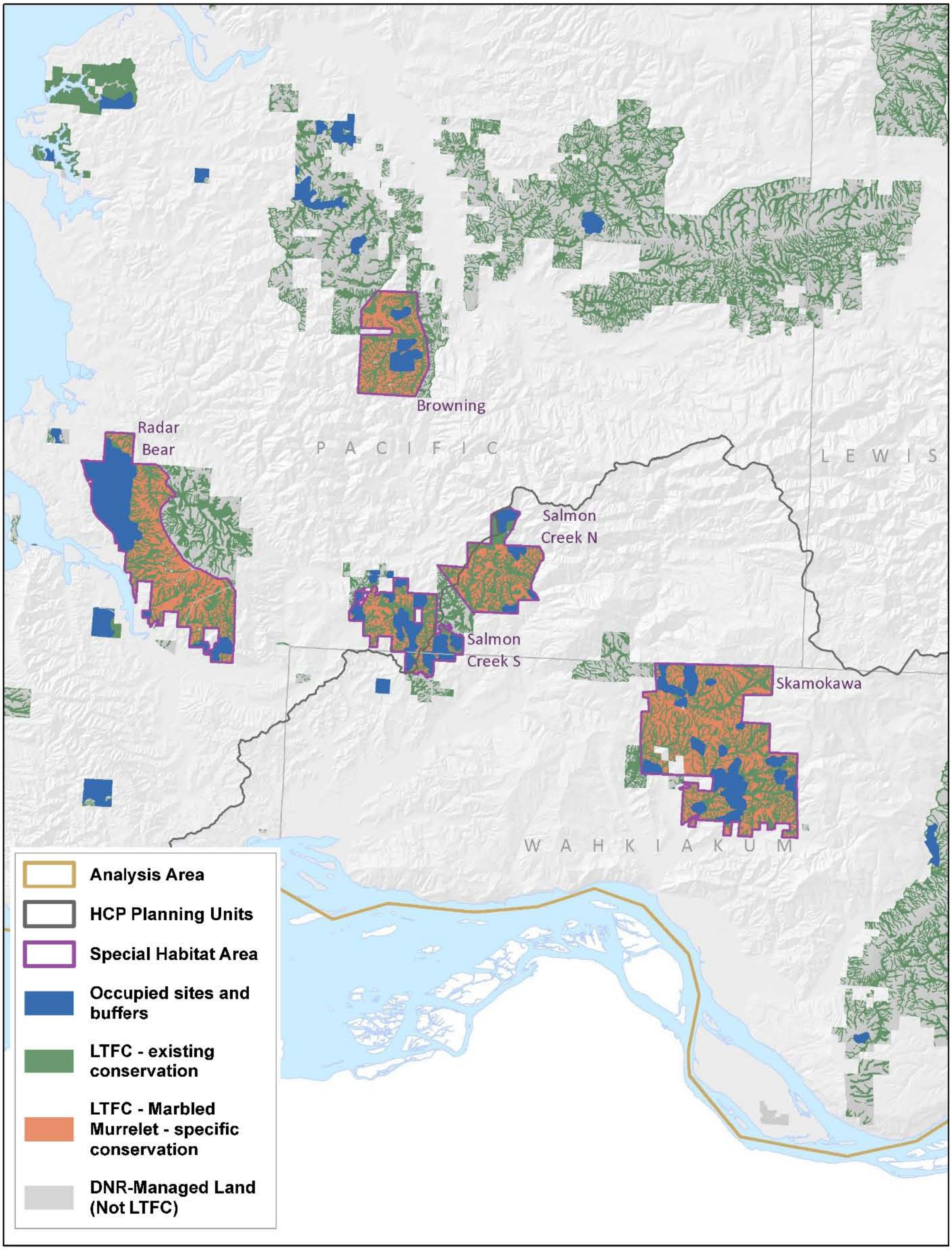


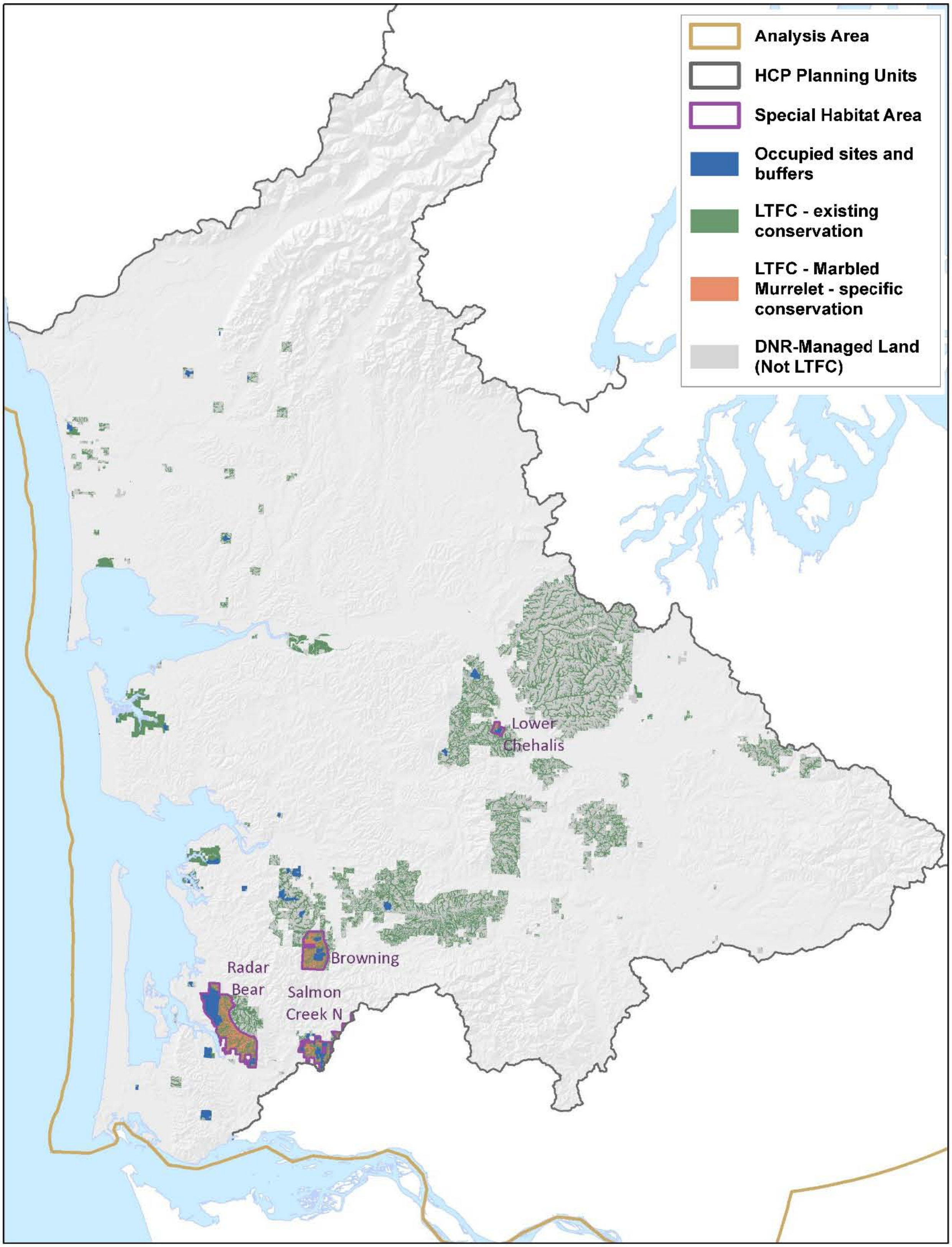
Alternative D: Special Habitat Areas, Columbia planning unit



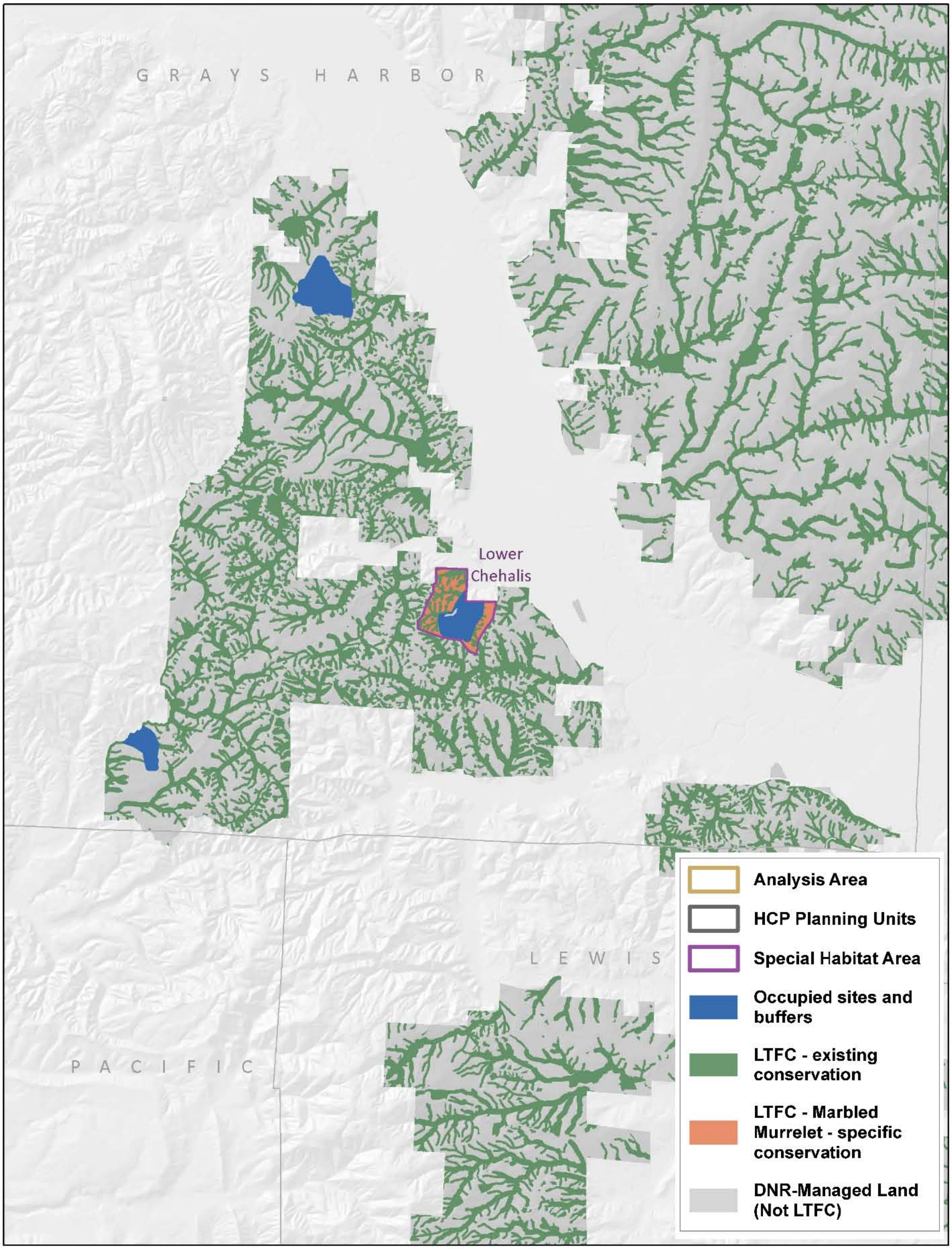
Alternative D: Columbia planning unit (north) and South Coast planning unit (south)



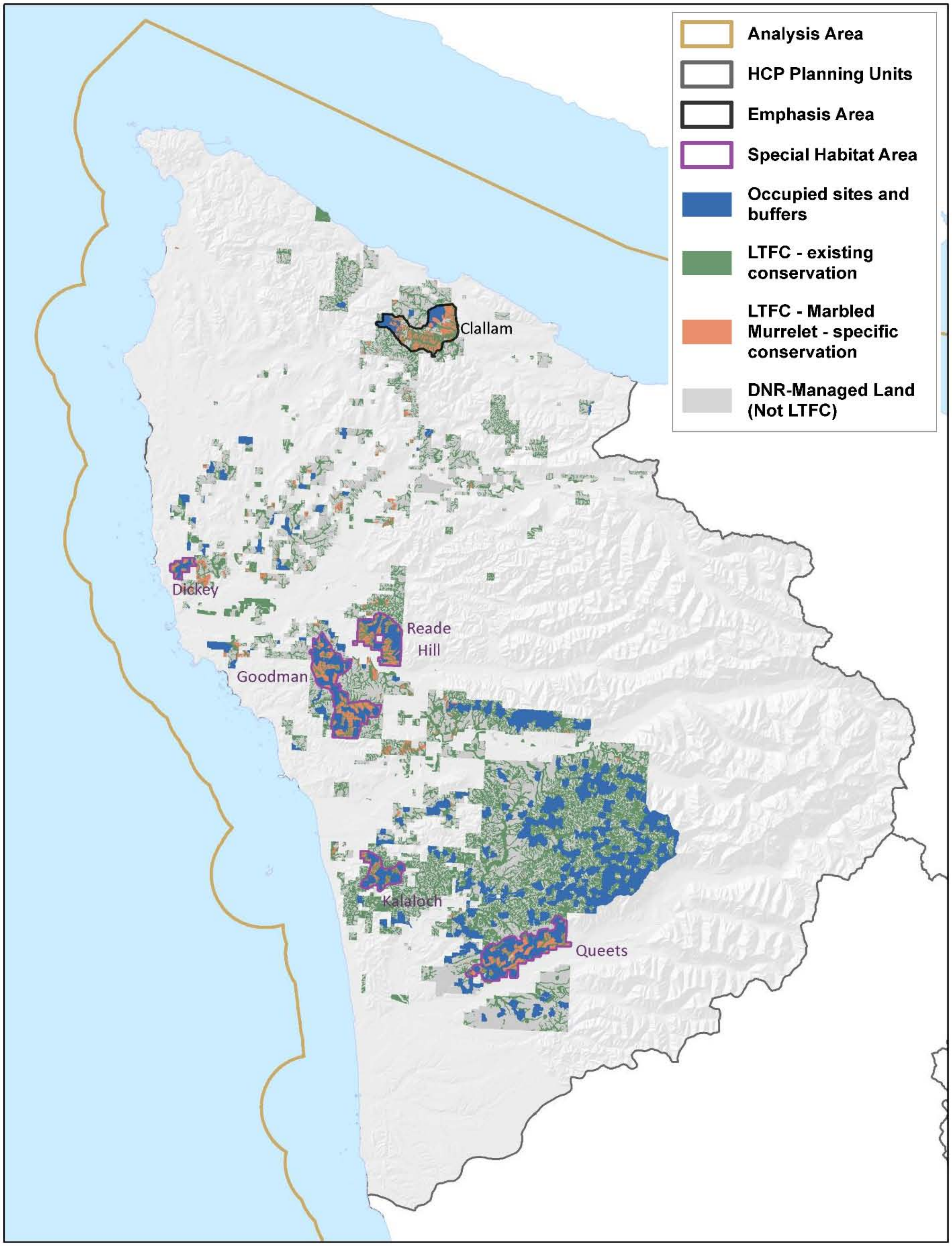
Alternative D: South Coast planning unit



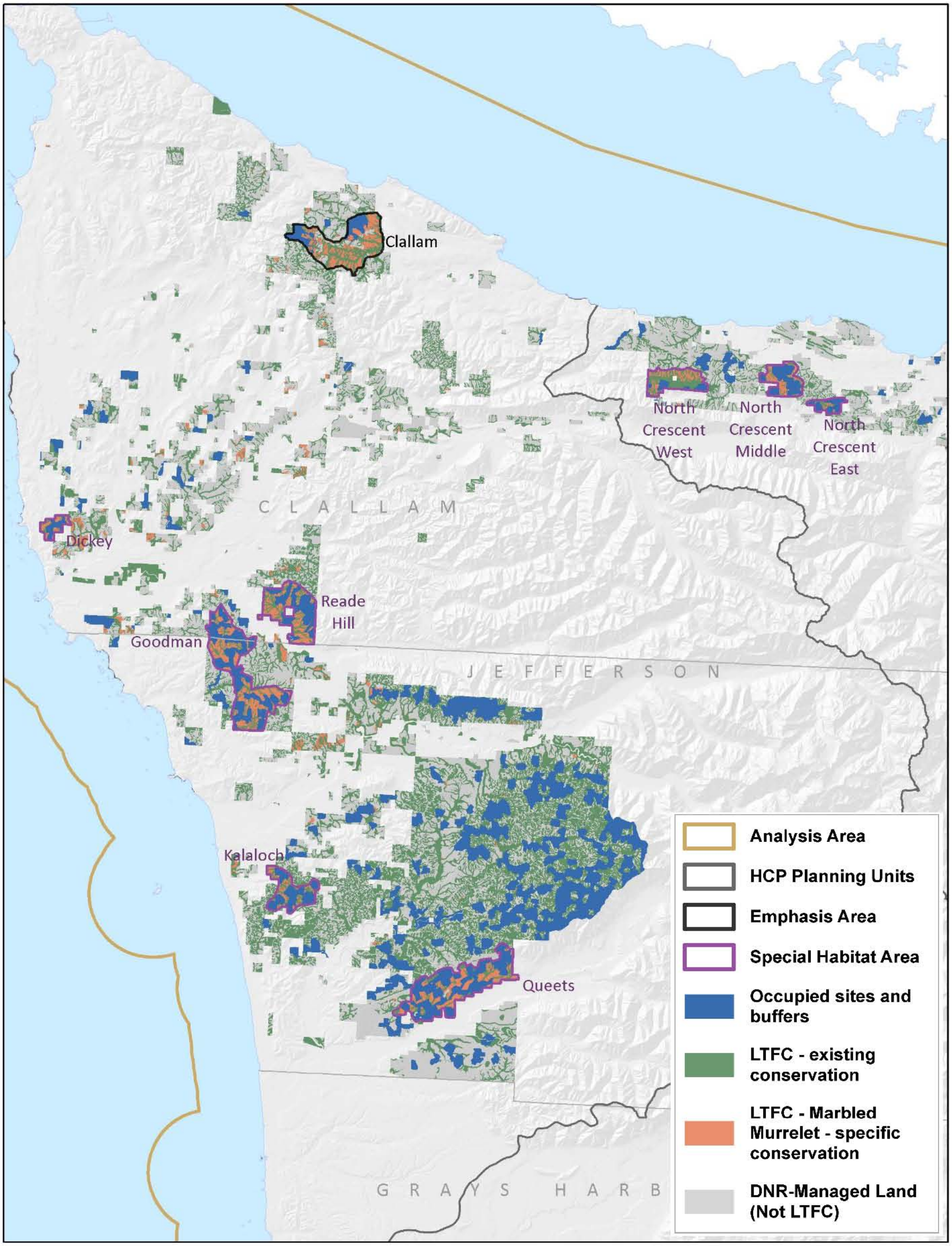
Alternative D: Special Habitat Areas, South Coast (north)



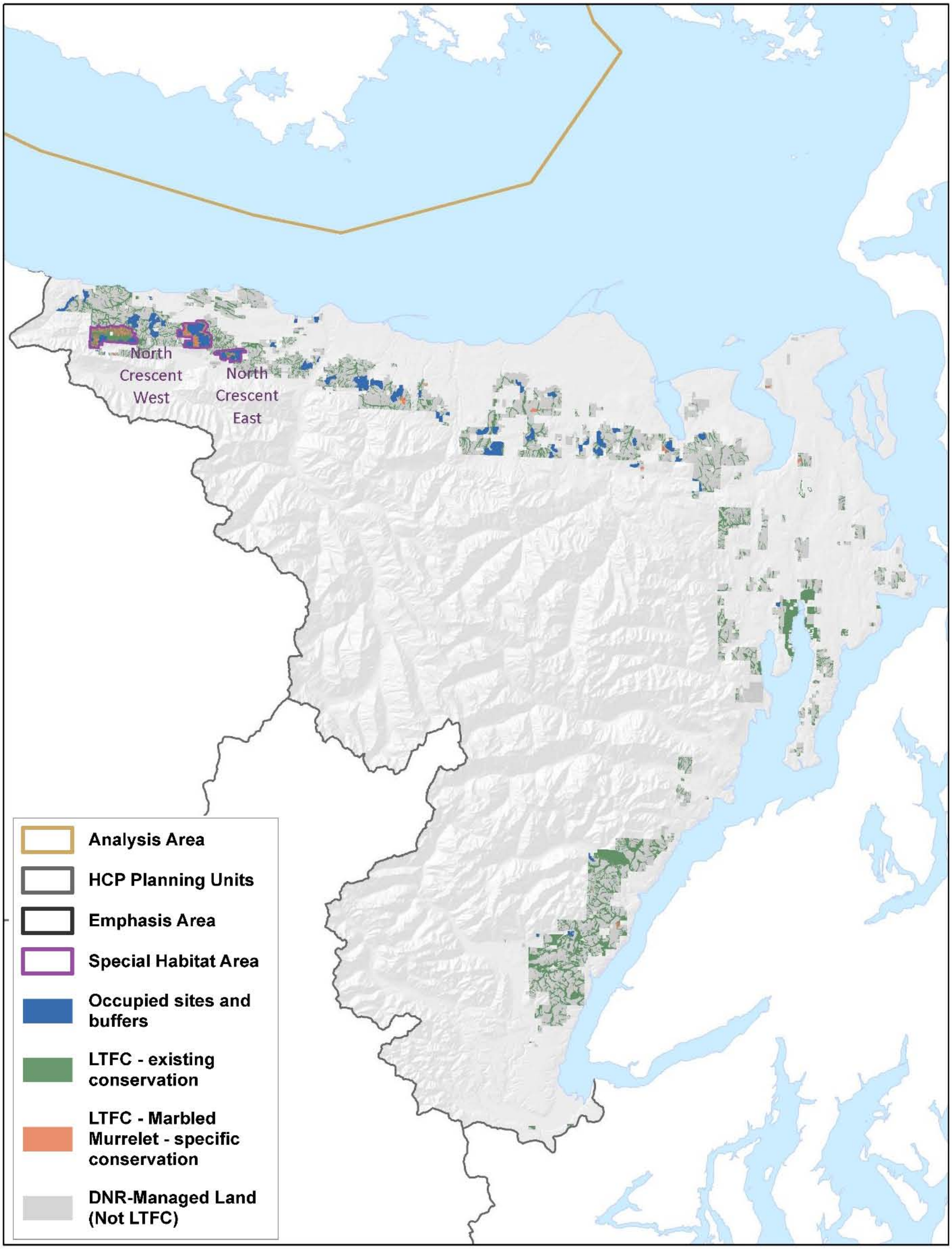
Alternative E: OESF planning unit



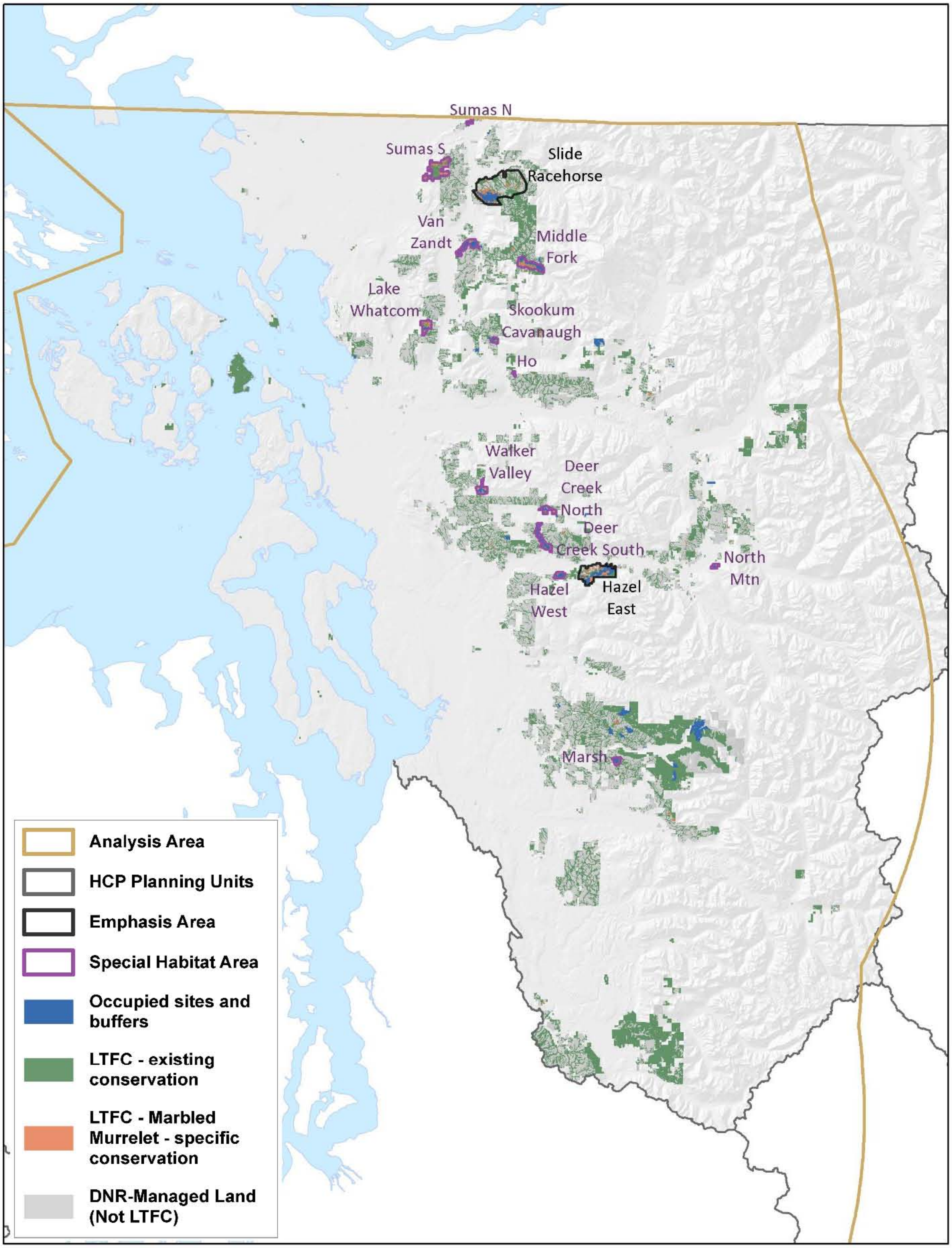
Alternative E: OESF planning unit (north) and portion of Straits planning unit



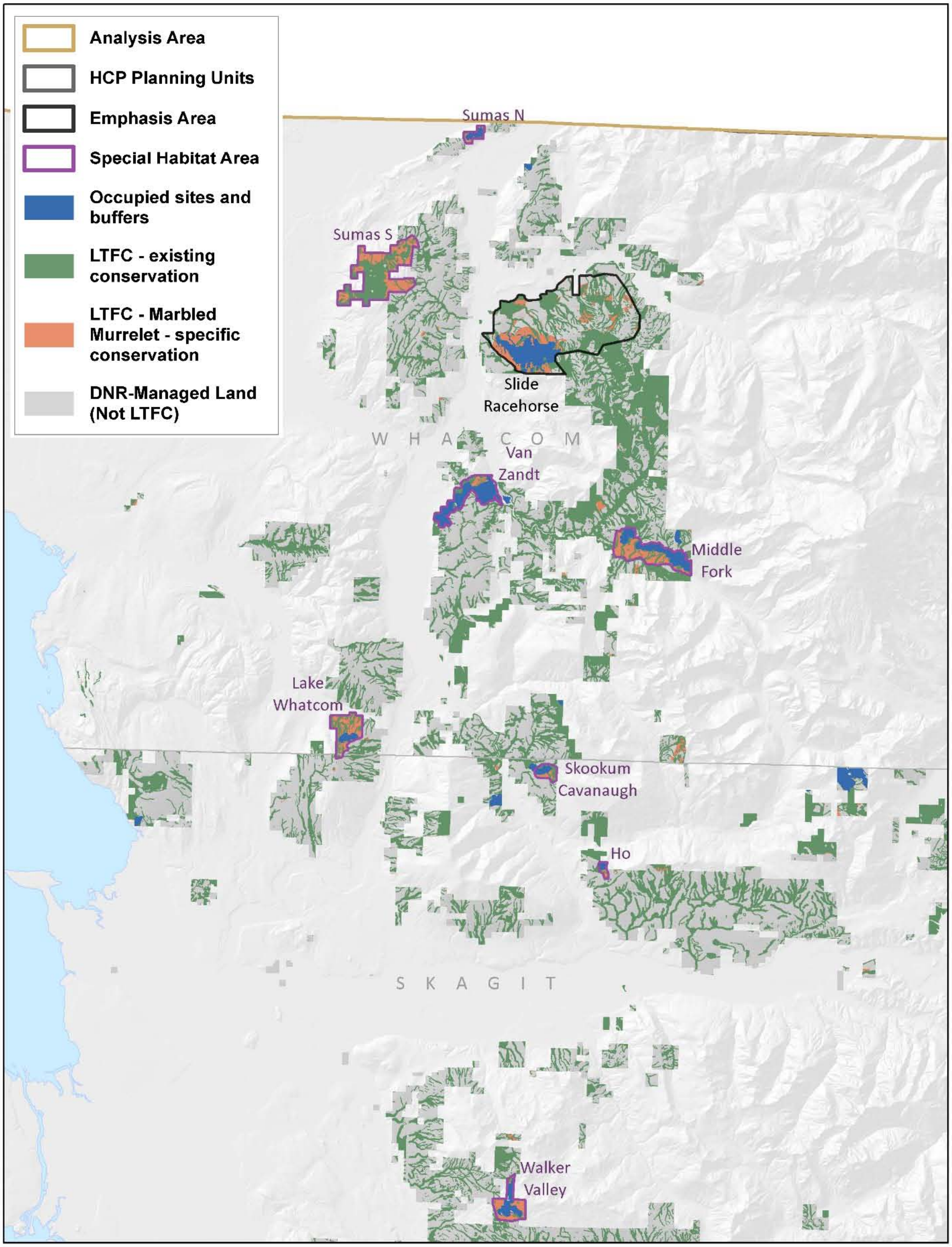
Alternative E: Straits planning unit



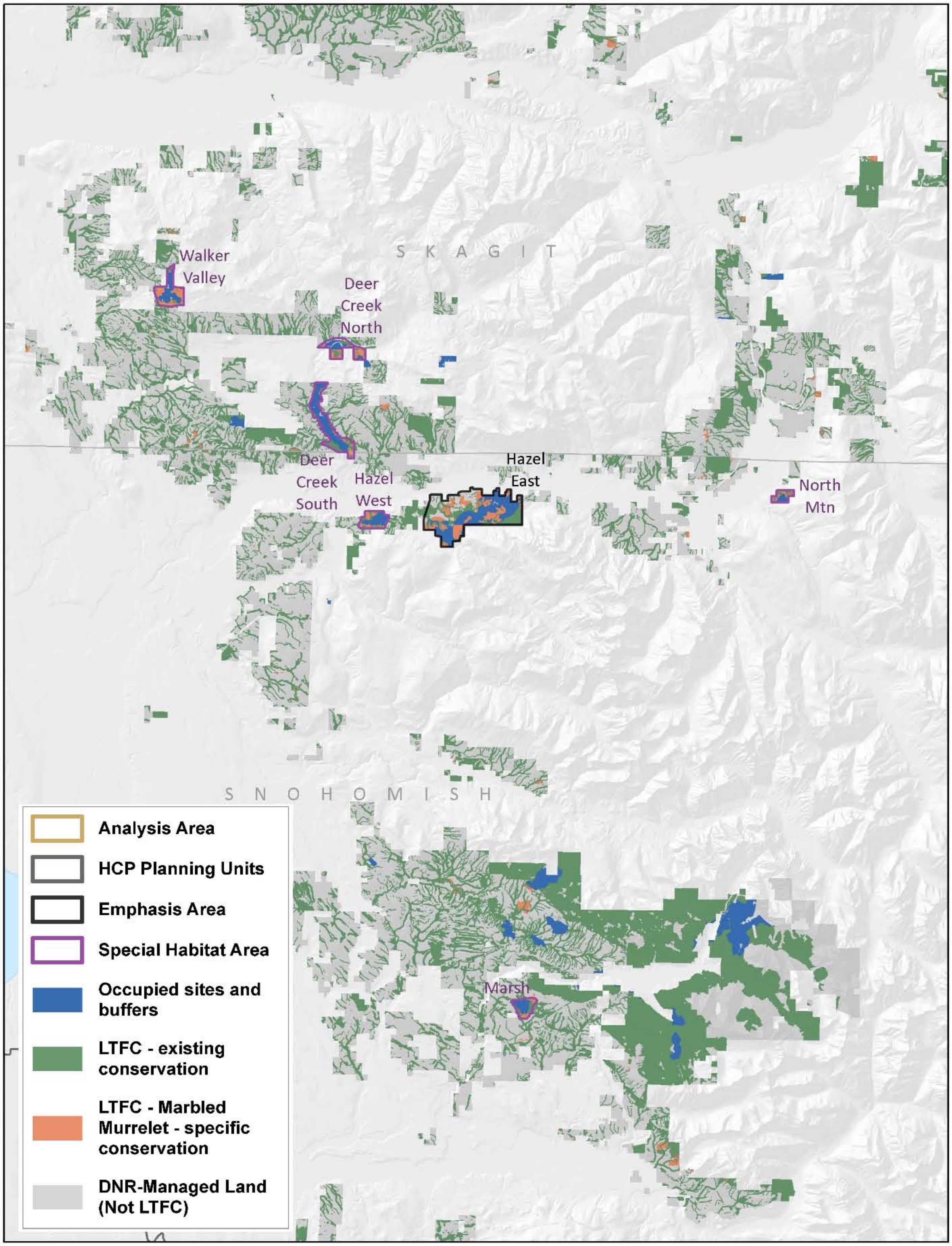
Alternative E: North Puget planning unit



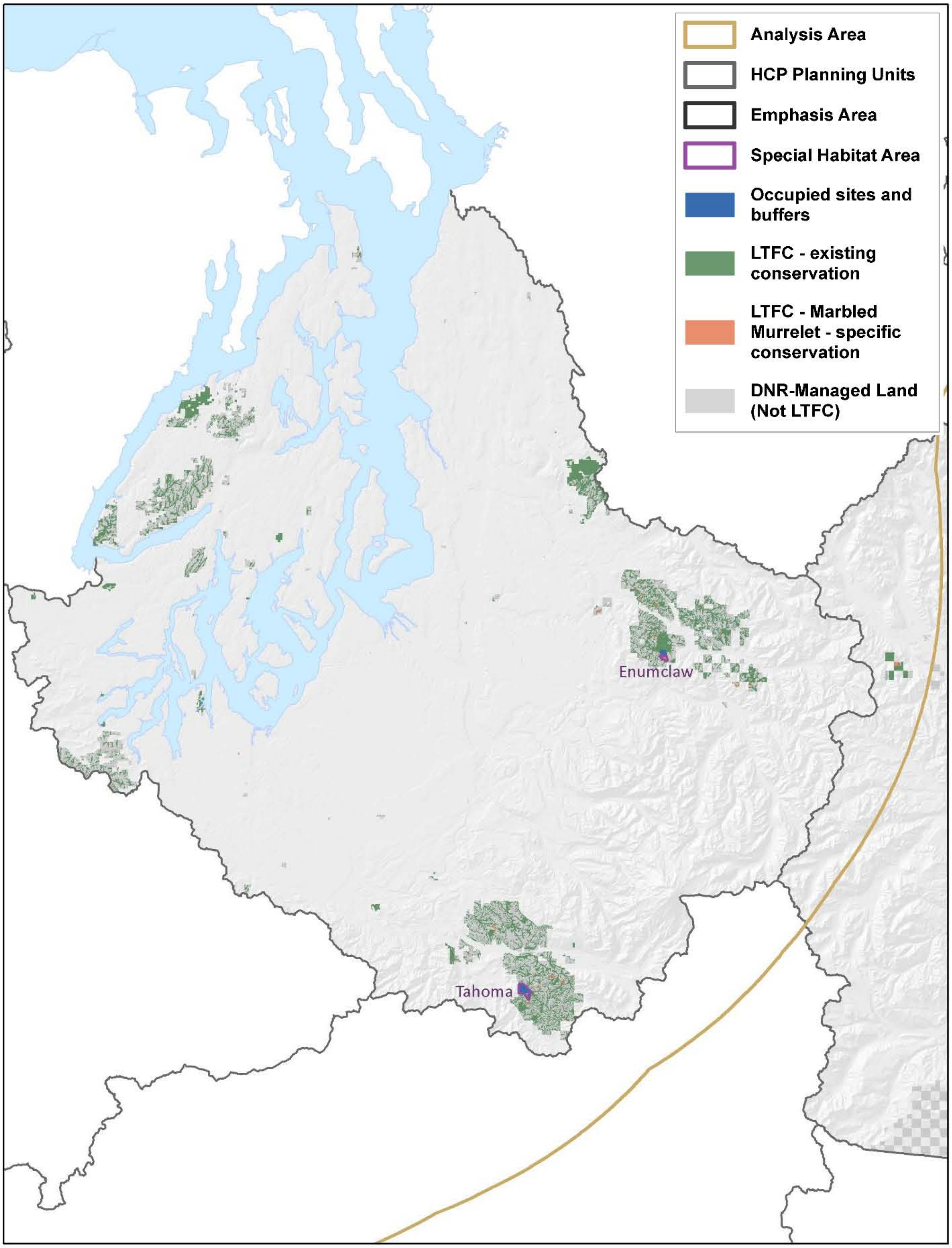
Alternative E: Emphasis Areas and Special Habitat Areas, North Puget planning unit (north)



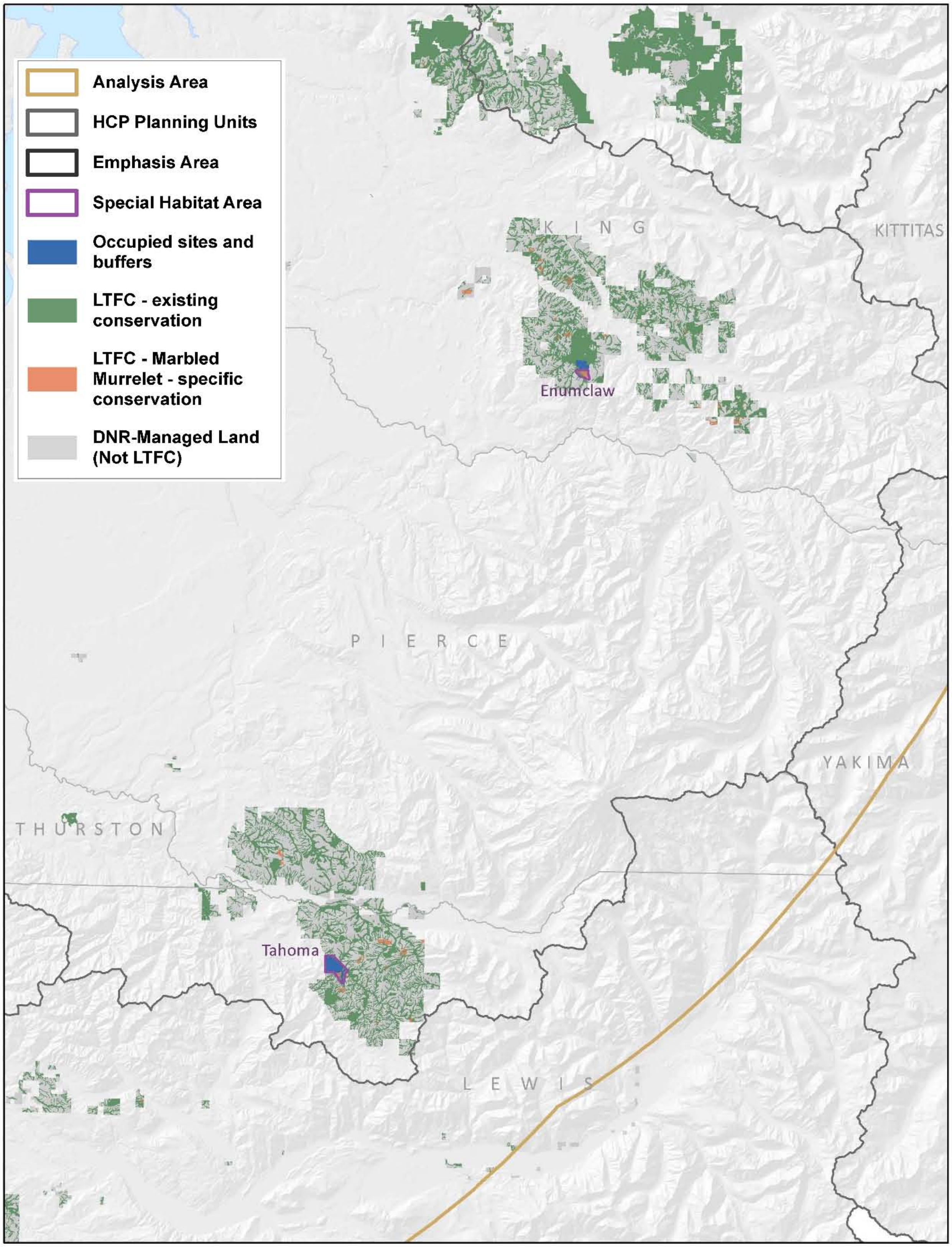
Alternative E: Emphasis Areas and Special Habitat Areas, North Puget planning unit (south)



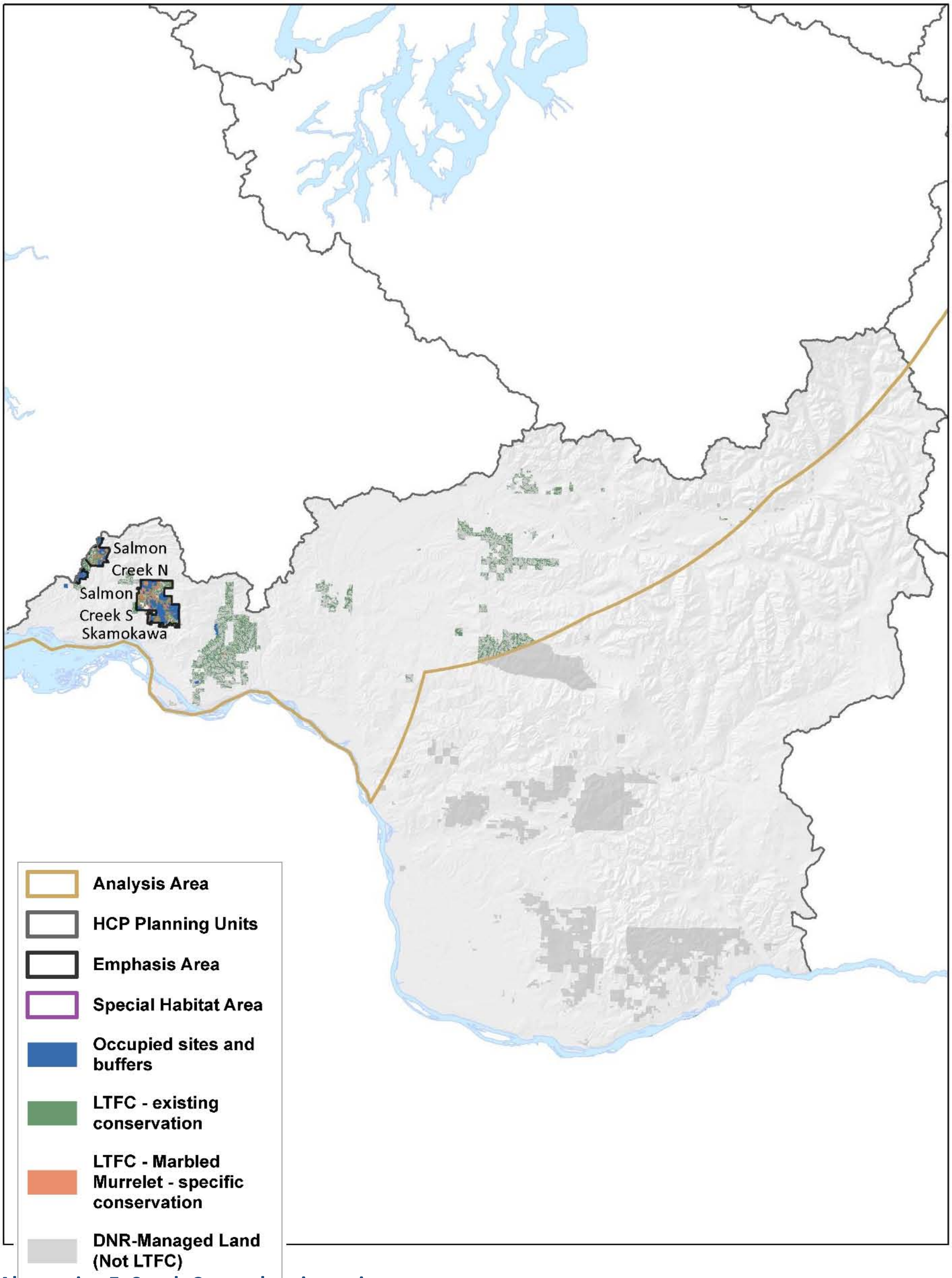
Alternative E: South Puget planning unit



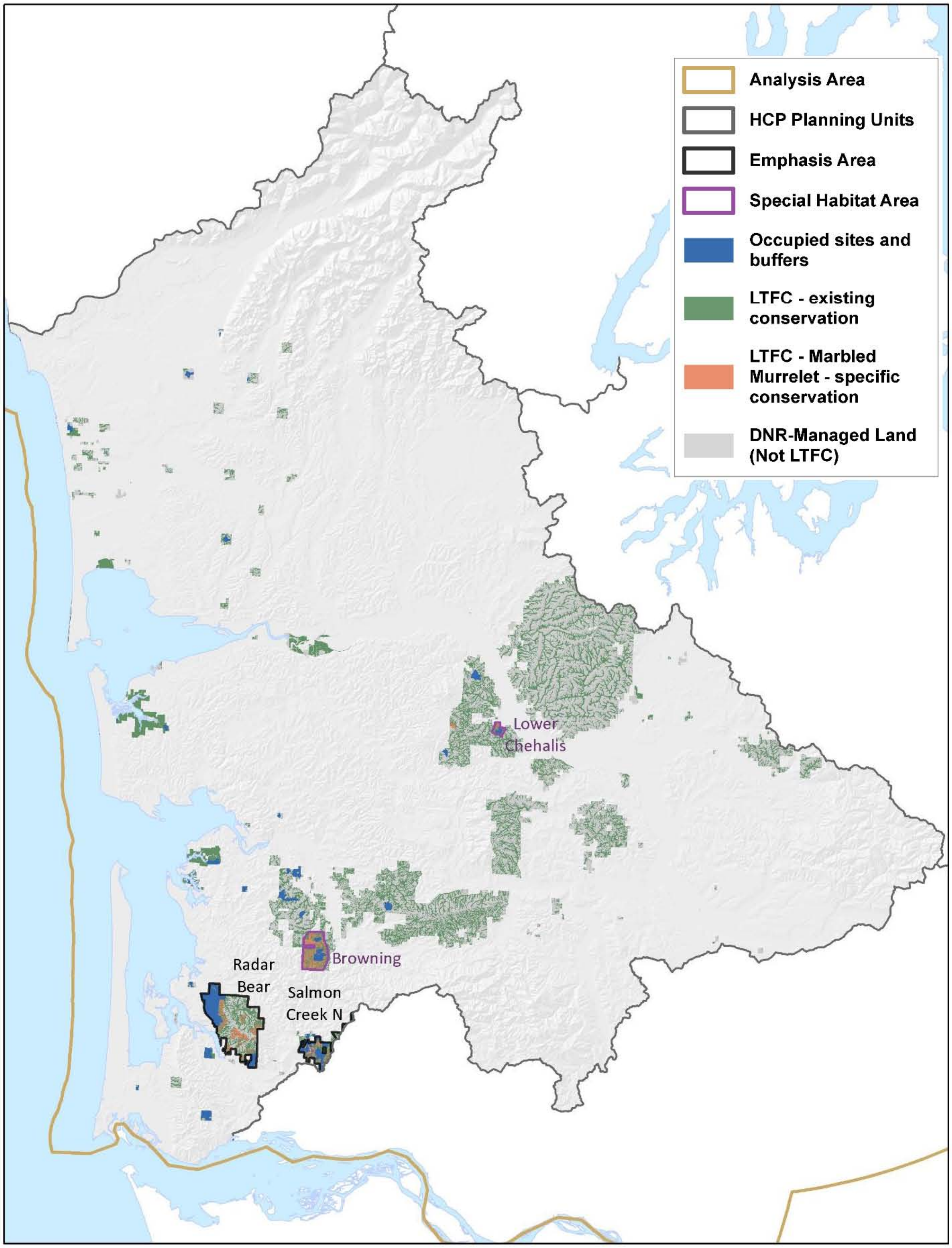
Alternative E: Emphasis Areas and Special Habitat Areas, South Puget planning unit



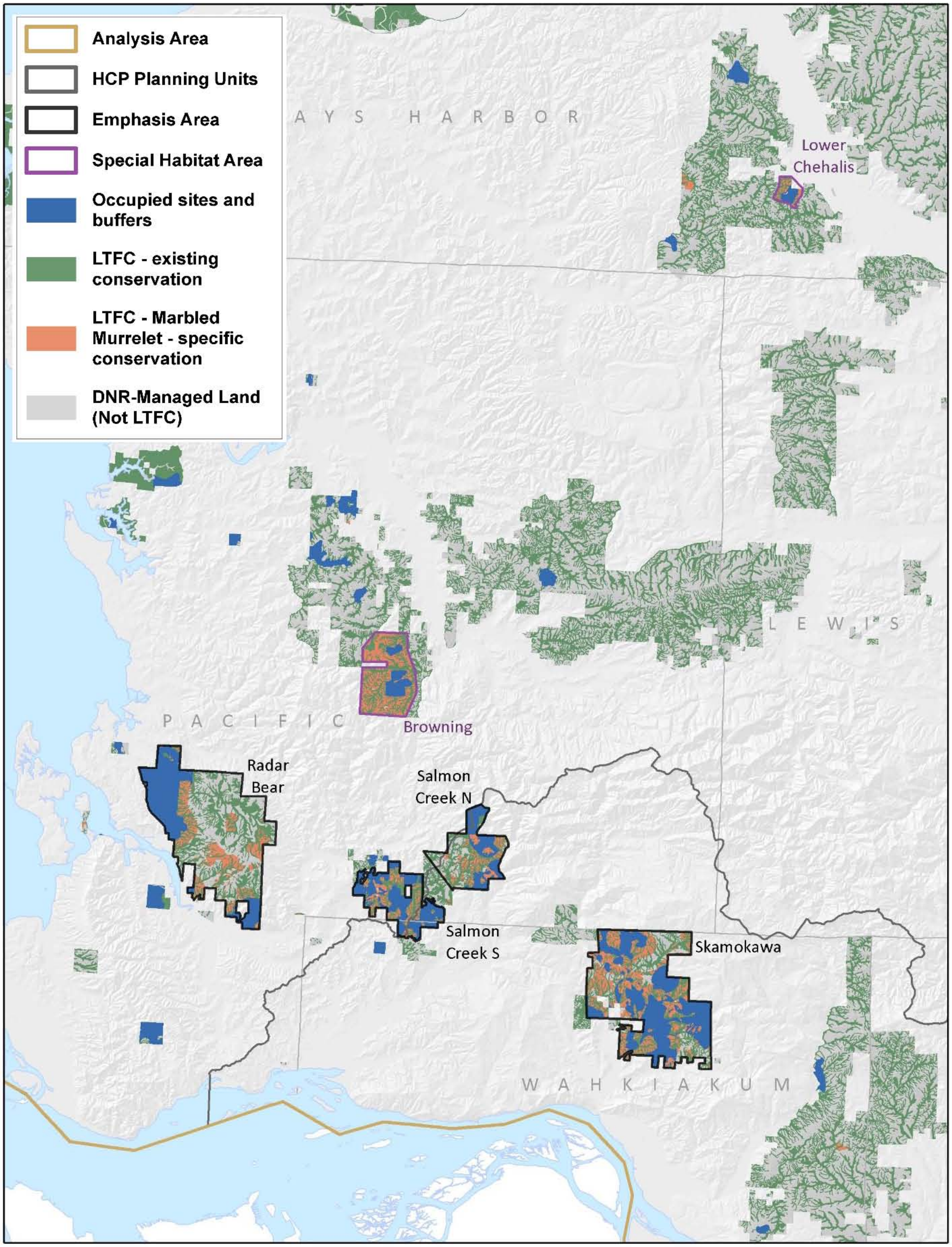
Alternative E: Columbia planning unit



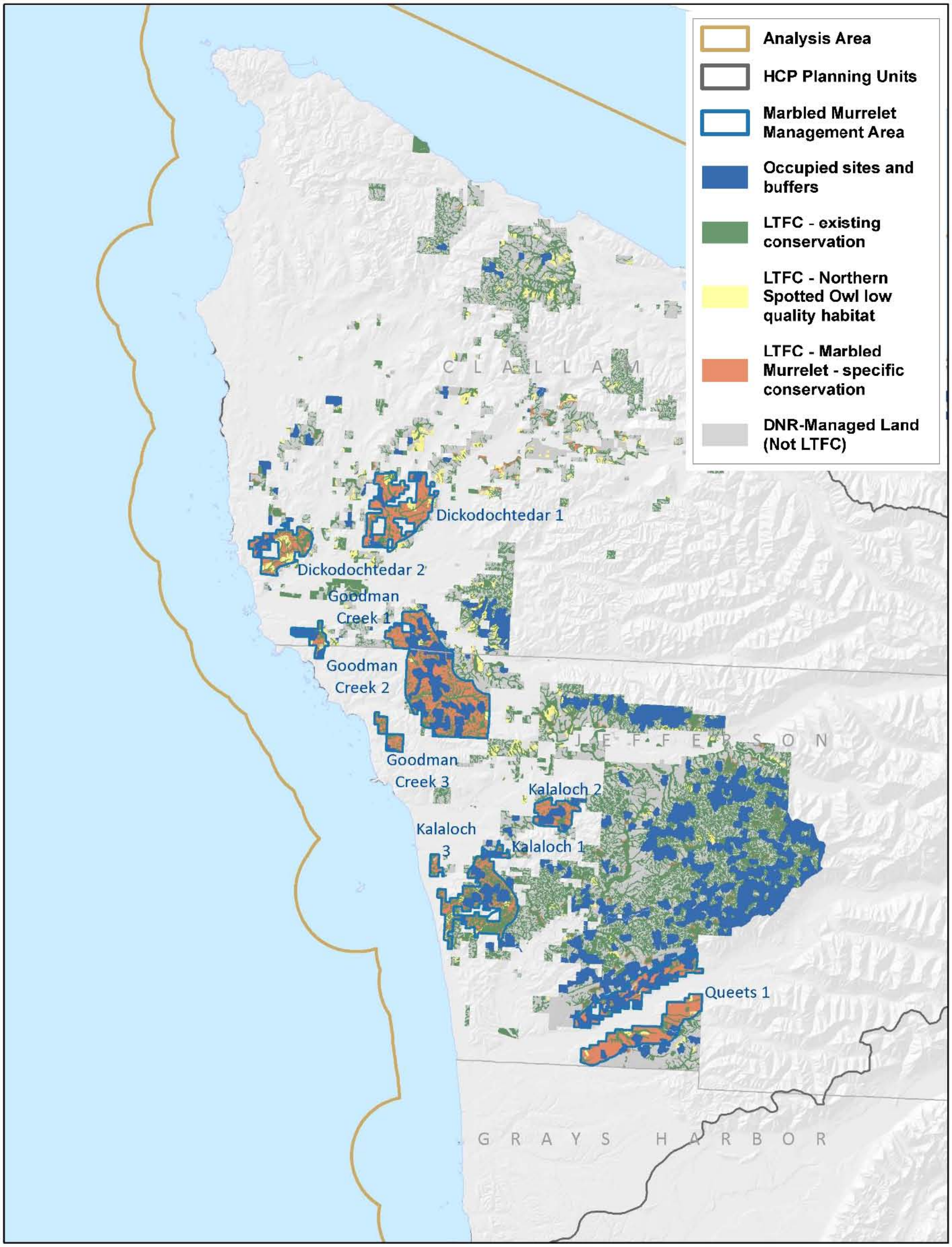
Alternative E: South Coast planning unit


Analysis Area
HCP Planning Units
Emphasis Area
Special Habitat Area
Occupied sites and buffers
LTFC - existing conservation
LTFC - Marbled Murrelet - specific conservation
DNR-Managed Land (Not LTFC)
Lower Chehalis
Browning
Radar Bear
Salmon Creek N

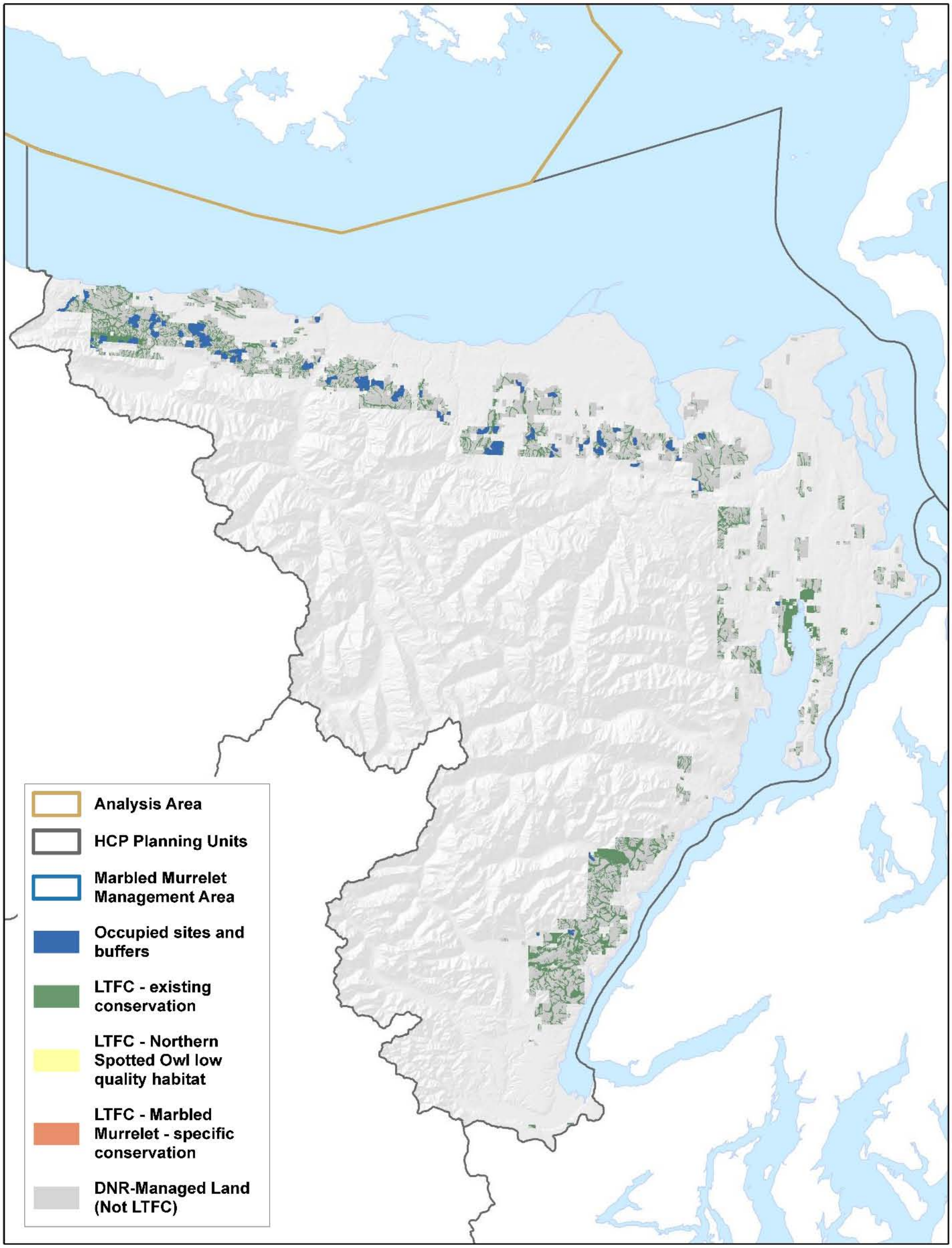
Alternative E: Emphasis Areas and Special Habitat Areas, South Coast and Columbia planning units



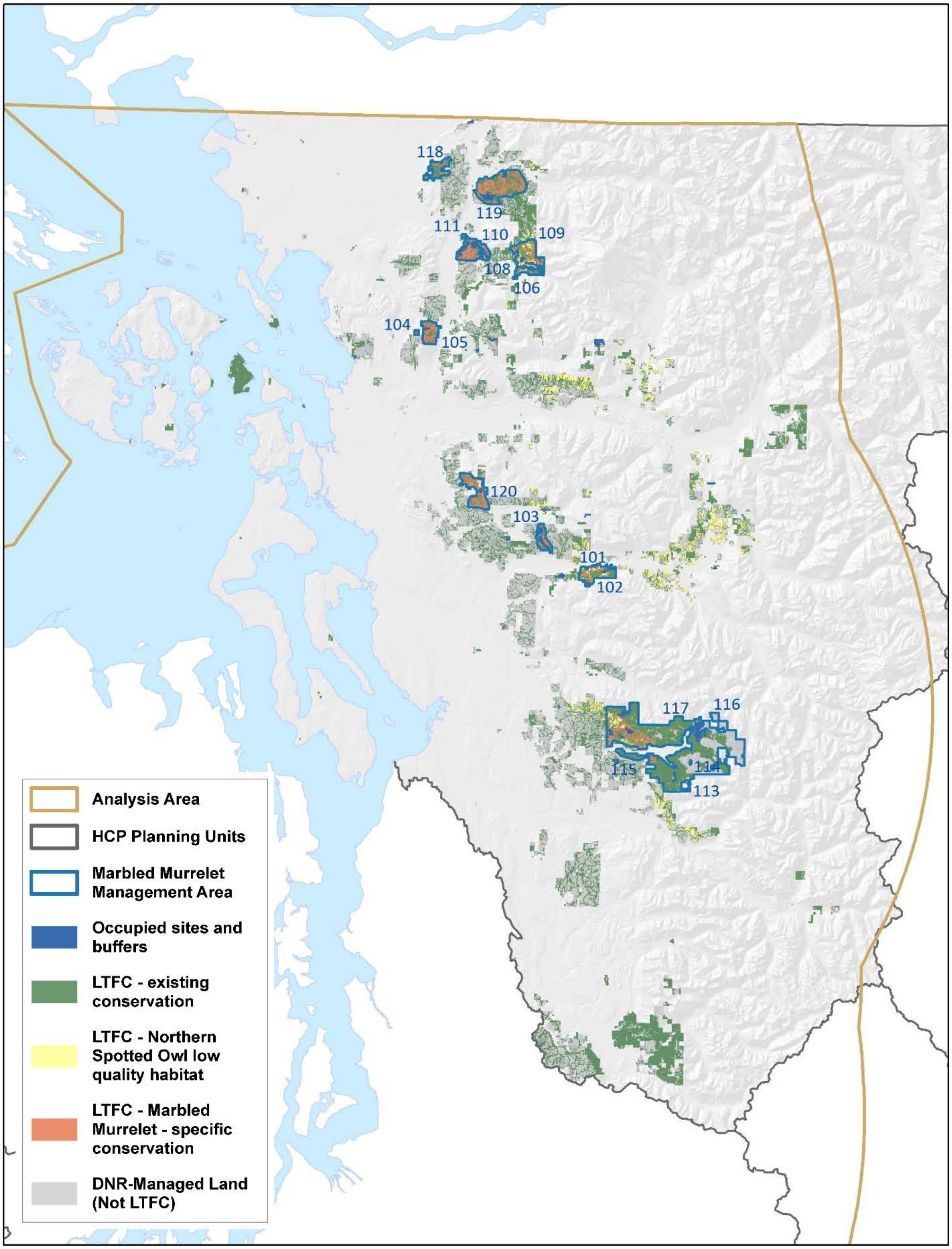
Alternative F: OESF planning unit



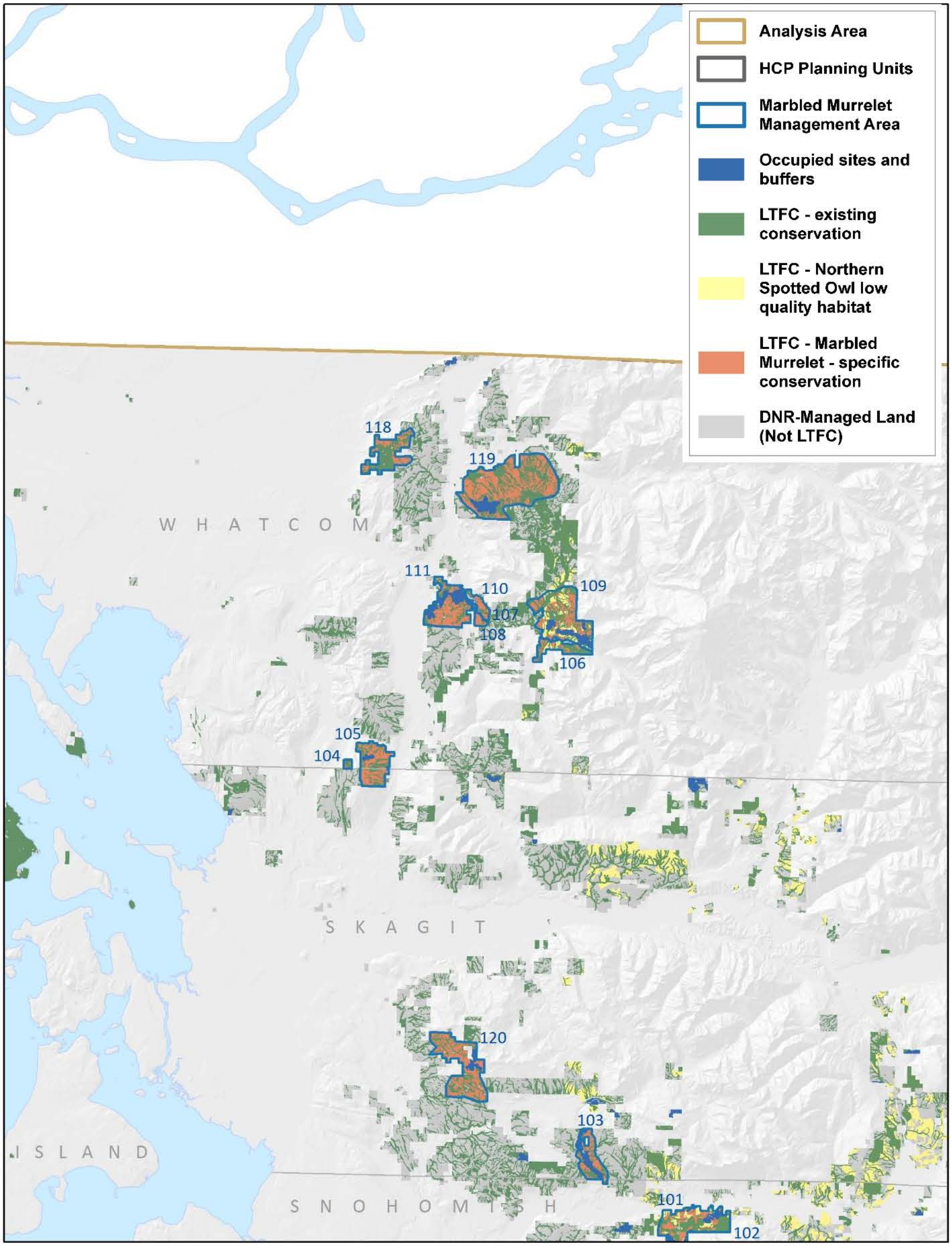
Alternative F: Straits planning unit



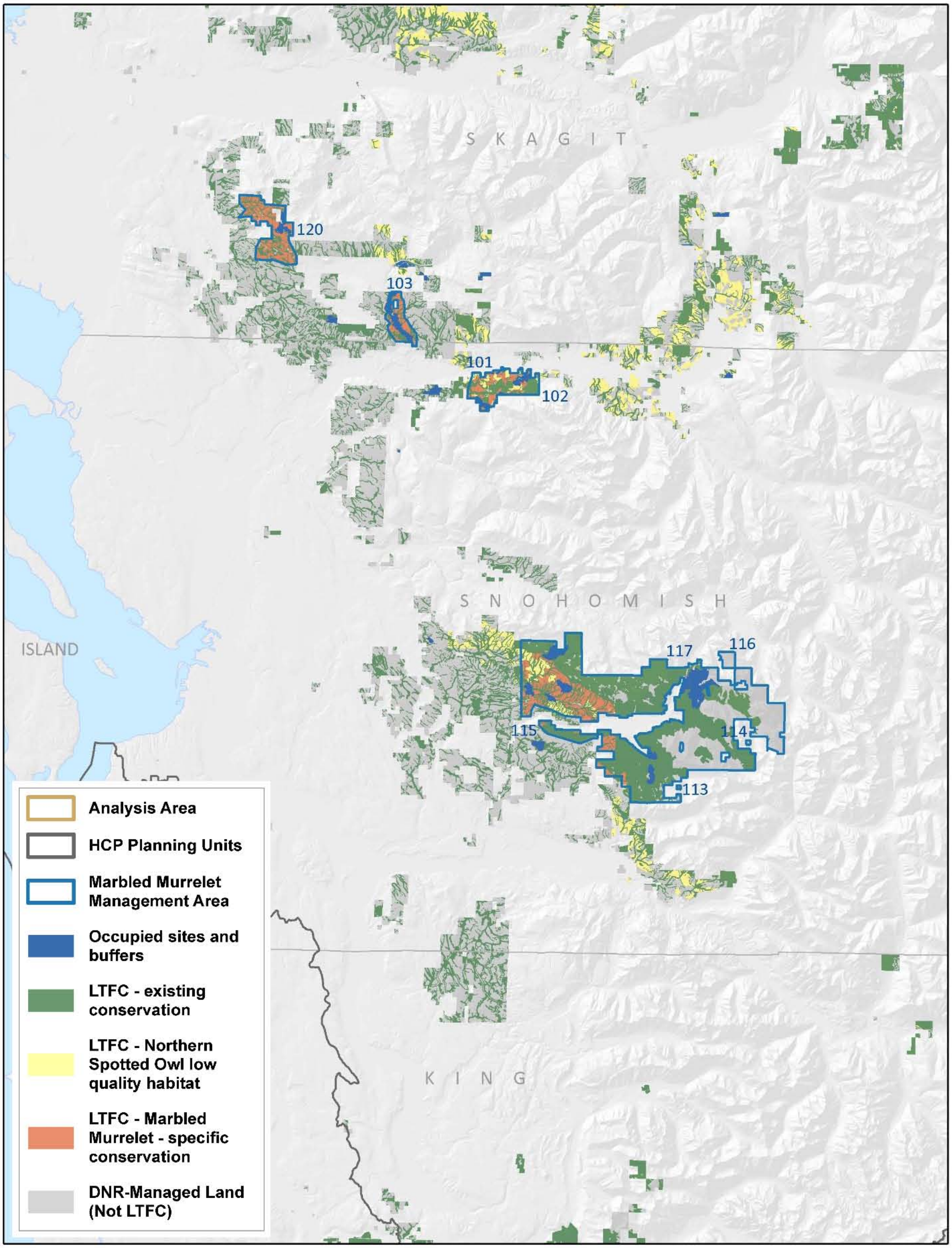
Alternative F: North Puget planning unit



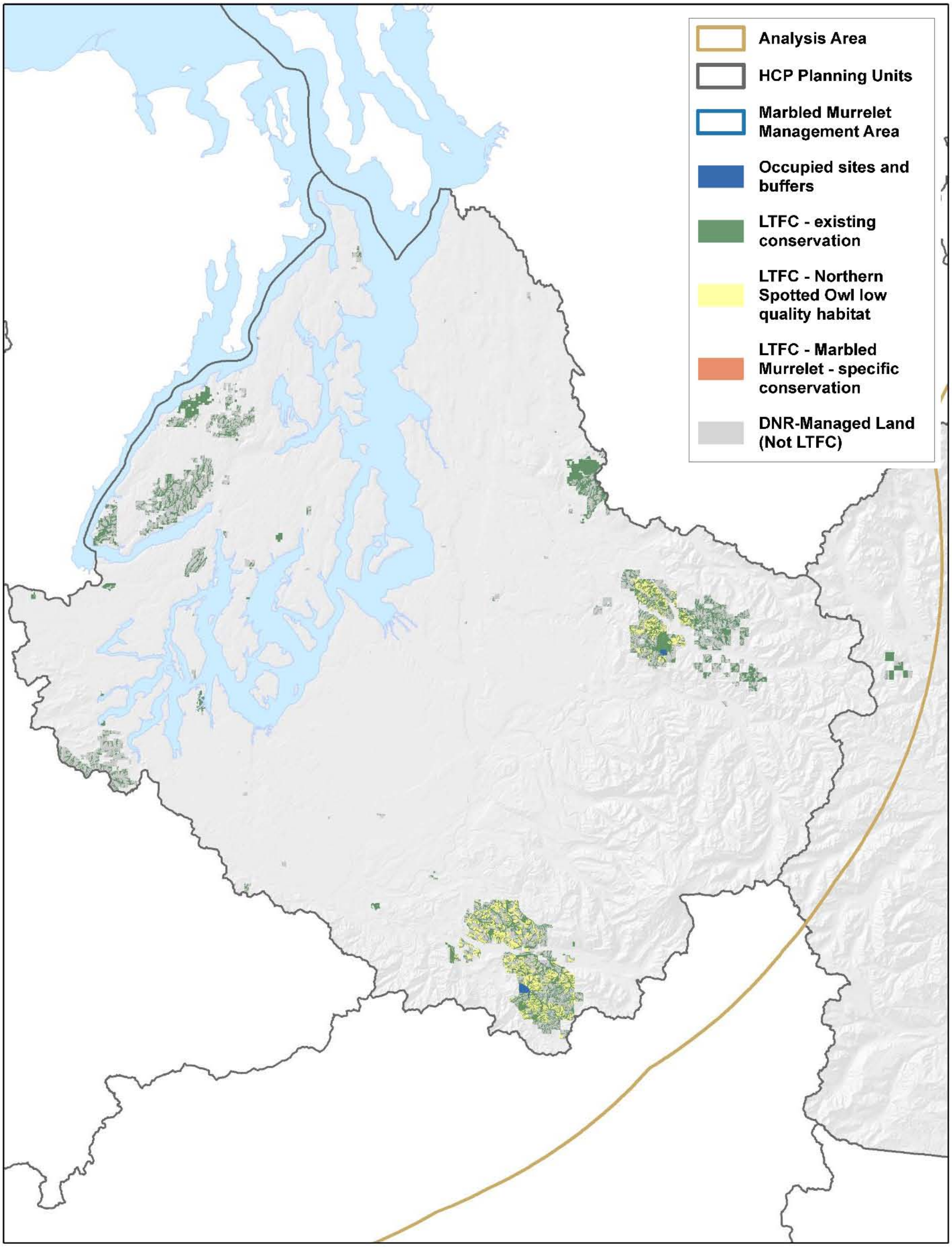
Alternative F: MMMAs, North Puget planning unit (north)



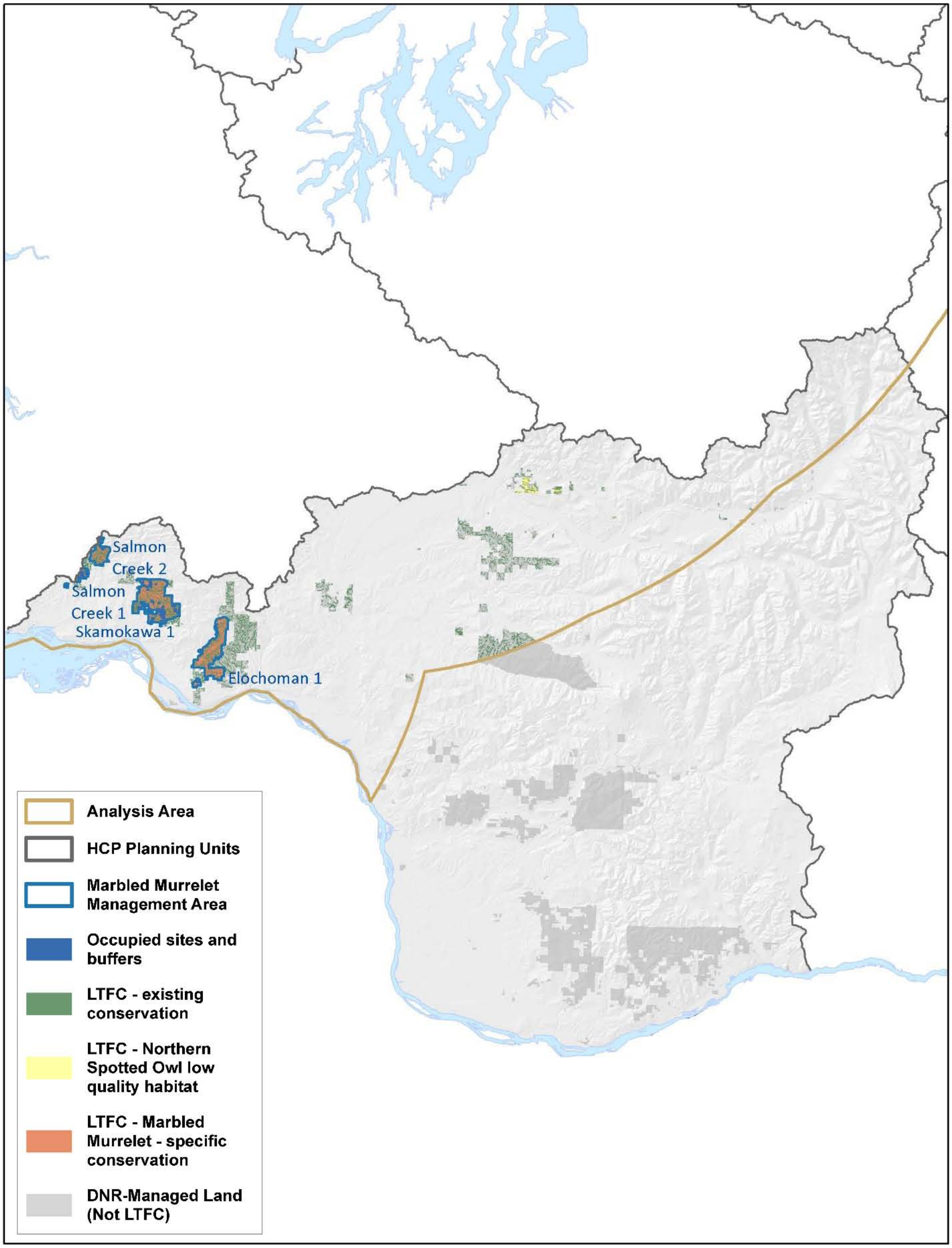
Alternative F: MMMAs, North Puget planning unit (south)



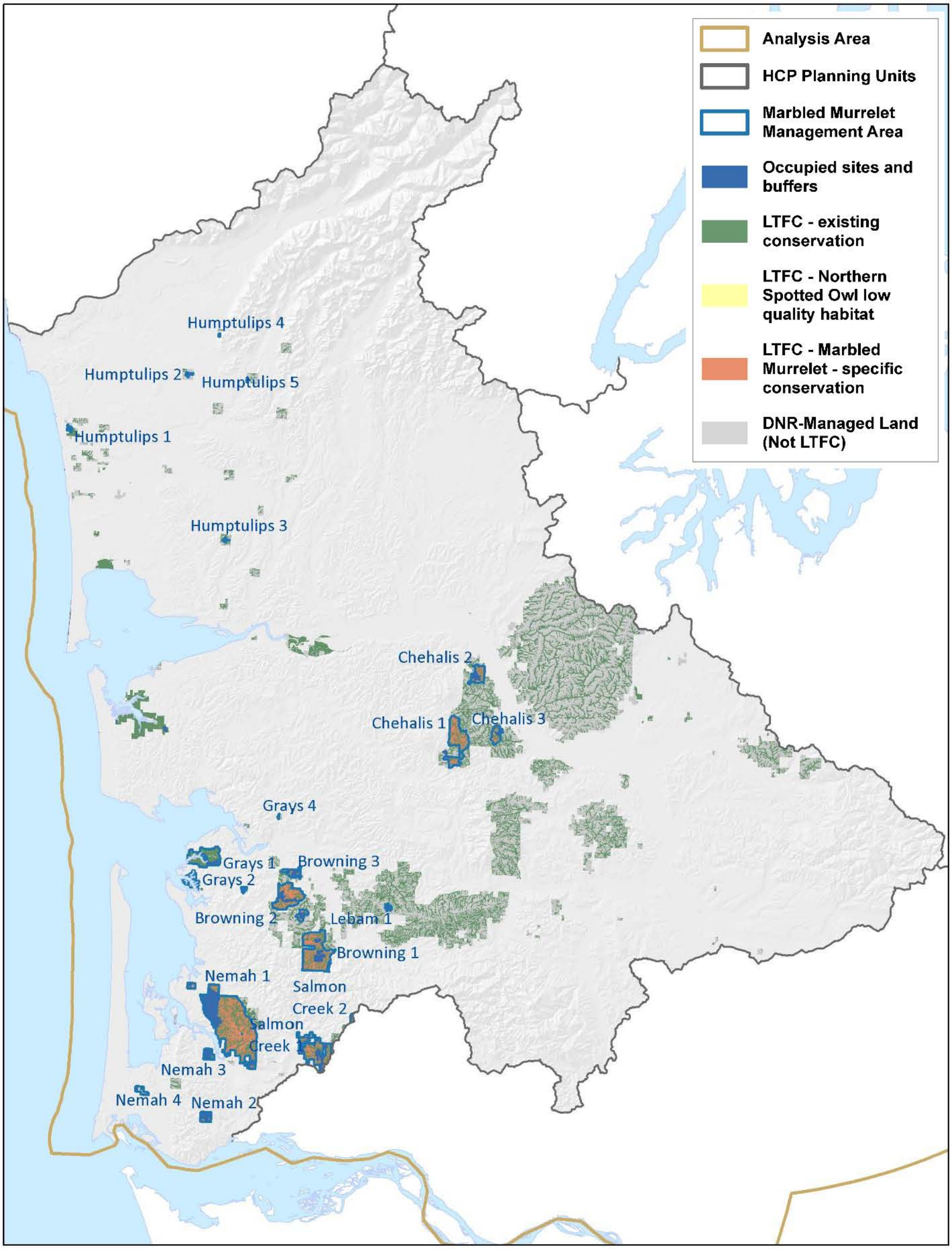
Alternative F: South Puget planning unit (no MMMAs)



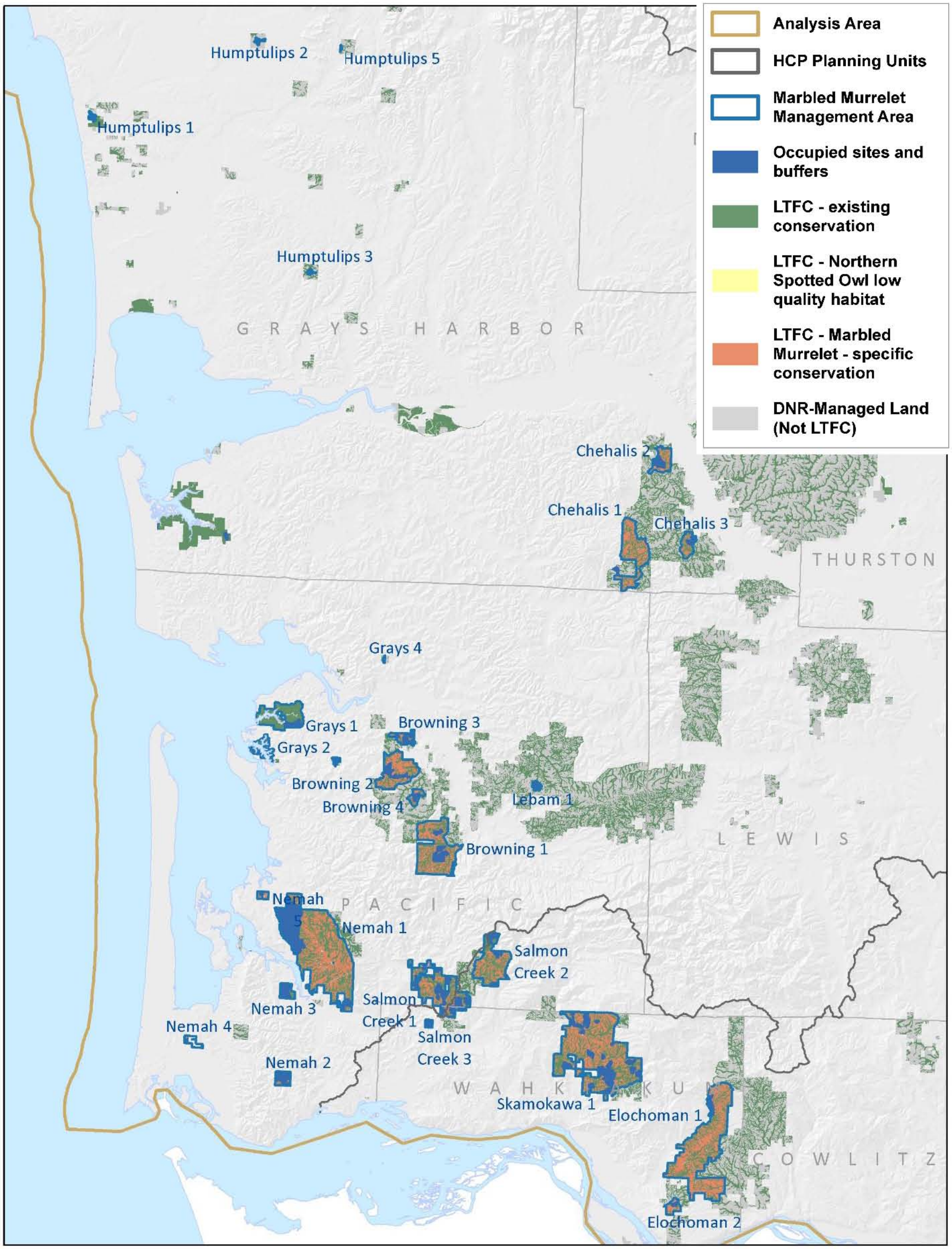
Alternative F: Columbia planning unit



Alternative F: South Coast planning unit



Alternative F: South Coast planning unit MMMAs



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Appendix G. LTFC Focus Paper

Areas of Long-Term Forest Cover

Focus Paper #2

This focus paper was part of a series presented to the Board of Natural Resources in October and November 2015 to inform development of the marbled murrelet long-term conservation strategy alternatives.

Introduction

Evidence from most research on marbled murrelet nesting ecology supports the murrelets' requirement for complex-structured forests with large trees. These trees provide large, moss-covered limbs that become nesting platforms. Other research identifies impacts from timber harvest on the availability of nest sites, and on nest success due to increased predation on eggs and nestlings near forest edges. Murrelets therefore rely on conifer-dominated forest stands with large interior areas and high numbers of large, old trees. Forest stands with these characteristics provide nesting opportunities, contain limited amounts of edge, and provide cover from predators and adverse weather (Ralph and others 1995, cited in McShane and others 2004). These types of forest stands can be found on DNR-managed lands within the range of the marbled murrelet. In many cases, these stands are already designated by existing DNR policy to provide conservation benefits. The marbled murrelet long-term conservation strategy identifies forest lands that will be managed as areas of *long-term forest cover*, which may have current habitat or have the capability to develop into the types of structurally complex forests needed for nesting by the murrelet. These areas will be managed to maintain forest cover over the life of the Habitat Conservation Plan.

How do DNR-managed forest lands contribute to marbled murrelet conservation?

DNR-managed forest lands are subject to several laws and department policies guiding their management. The following documents have the most direct impact on how forests are managed for purposes of marbled murrelet conservation:

- The 1997 State Trust Lands Habitat Conservation Plan (HCP), a 70-year agreement between the federal services and DNR, describes a set of management strategies that DNR employs to offset any incidental take caused to individual listed animals, and promotes conservation of the species as a whole. The HCP was amended in 2004 in the Klickitat Planning Unit to better implement northern spotted owl habitat conservation strategies.[1] The HCP included an *interim strategy* for marbled murrelet conservation. In addition, concurrence letters between DNR and U.S. Fish and Wildlife Service further specified procedures for identifying and protecting marbled murrelet habitat in the North Puget (2007) and South Puget (2009) HCP planning units.
- The 2006 Policy for Sustainable Forests (PSF) contains the vision of the Board of Natural Resources and DNR for the management of current and future forests on state trust lands. PSF policies are specifically designed to achieve DNR's fiduciary responsibilities by generating revenues for trust beneficiaries, while meeting DNR's obligations under the 1997 HCP.

The analysis area for the marbled murrelet long-term conservation strategy includes just over 1.3 million acres of DNR-managed lands.[2] These lands are managed for a multiple set of objectives including timber production, conservation, recreational and resource land uses. With such a large area and variety of land types and land uses, the development of a long-term conservation strategy takes advantage of a landscape planning approach towards conservation.

DNR collects and maintains information on the forest lands it manages. These data are used to determine where, when and how timber harvest is likely to happen, as well as where on the landscape forests are likely to be maintained and/or conserved over time. For example, some forest stands may be deferred from harvest because they are designated as existing old-growth forests, or serve as gene pool reserves for native trees species. Areas may also be deferred from harvest due to slope stability issues or other local knowledge of ecologically, socially, or culturally important areas. Other forest areas may be managed to maintain forest cover or certain forest structural conditions to achieve wildlife habitat objectives for species covered by the HCP (including the northern spotted owl, salmonids, and other aquatic and riparian obligate species). DNR also manages lands under the state Natural Areas Preserves Act, which dedicates Natural Areas (including Natural Resource Conservation Areas and Natural Area Preserves) in perpetuity for education, scientific research, and conservation of native biological diversity. Together, these DNR forest lands are managed to maintain forest cover[3] for conservation; they provide the building blocks for a landscape approach to the long-term conservation strategy for the marbled murrelet.

The conservation strategy defines these areas as long-term forest cover (LTFC), which may provide potential nesting habitat for marbled murrelet or insulate that habitat from impacts from forest

[1] Washington State Department of Natural Resources. 2004. HCP Amendment No. 1, Administrative Amendment to the Northern Spotted Owl Conservation Strategy for the Klickitat HCP Planning Unit, April 2004.
[2] See Focus Paper #1, "Analytical Framework," which describes the analysis area in more detail.
[3] "Forest cover" as used here refers to a relatively closed canopy structure, which may provide cover, security and potential nesting habitat to marbled murrelets.

management activities, both now and in the future. This approach implements a key objective of the marbled murrelet conservation strategy.[4]

What are areas of long-term forest cover?

Areas of LTFC can be found throughout DNR's managed forest landscape. These areas are defined and mapped using GIS information from DNR's databases.[5] Areas of LTFC come in various shapes and sizes, and when in a strategic location and suitable habitat condition provide nesting opportunity for the marbled murrelet.[6] LTFC includes the following types of lands:

- Natural Area Preserves
- Natural Resources Conservation Areas
- Northern Spotted Owl habitat
- Riparian management zones
- Wetlands
- Areas of slope stability concern
- Gene pool reserves
- Old-growth
- Local knowledge of ecological/social and culturally important areas
- Marbled murrelet occupied sites[7]
- Areas specifically designated for marbled murrelet conservation in strategic locations under each of the alternatives.

The areas above, layered together (as illustrated in Figure 1), create blocks of land that contribute to marbled murrelet conservation, if the structure and complexity of the forest within provides nesting habitat and security from predation.[8]

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[4] Objective #2 of the marbled murrelet conservation strategy: "Provide forest conditions in strategic locations on forested trust lands that minimize and mitigate incidental take of marbled murrelets resulting from DNR's forest management activities. In accomplishing this objective, DNR and USFWS expect to make a significant contribution to maintaining and protecting marbled murrelet populations."

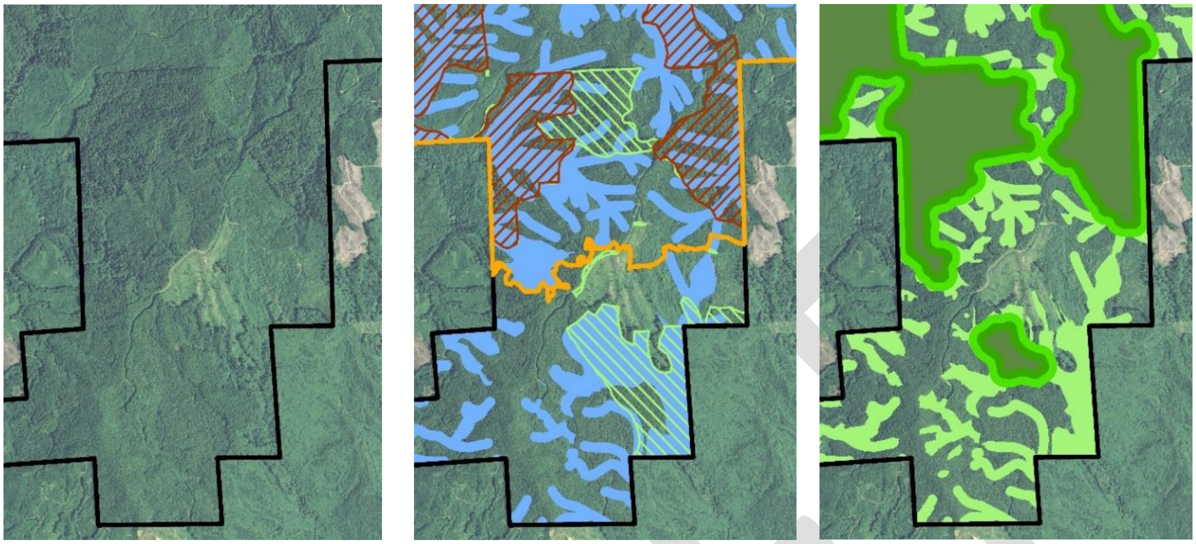
[5] DNR Large Data Overlay, 2015.

[6] See Objective #2 of the long-term conservation strategy: "Provide forest conditions in strategic locations on forested trust lands that minimize and mitigate incidential take of marbled murrelets resulting from DNR's forest management activities. In accomplishing this objective, we expect to make a significant contribution to maintaining and protecting marbled murrelet populations."

[7] See Focus Paper #4, "Occupied Sites." *Note: This paper will be available in late November 2015.*

[8] The varying quality of the habitat found within LTFC is analyzed using a mathematical model, described in Focus Paper #3, "Estimating the Location and Quality of Stands of Marbled Murrelet Habitat." *Note: This paper will be available in late November 2015.*

Figure 1. Layering Data to Map Areas of LTFC



Block of DNR-Managed Land

Occupied sites, riparian zones, other protected areas

Areas layered together to form LTFC (interior forest in darkest green, edges in lighter greens)

The precise boundaries of some categories of LTFC are accurately mapped in the DNR databases. Examples include gene pool reserves and natural areas. These boundaries are not expected to change throughout the life of the HCP. Other categories of LTFC are not precisely mapped but are approximated until field inspections can more accurately define correct boundaries. LTFC associated with riparian areas, wetlands, and unstable slopes are examples where the boundaries may be adjusted when site-specific information becomes available. Although the exact location of LTFC associated with riparian areas can change with field verification, the total acres of LTFC associated with these deferrals is a reasonably accurate estimate of the total LTFC expected to be retained on the landscape.

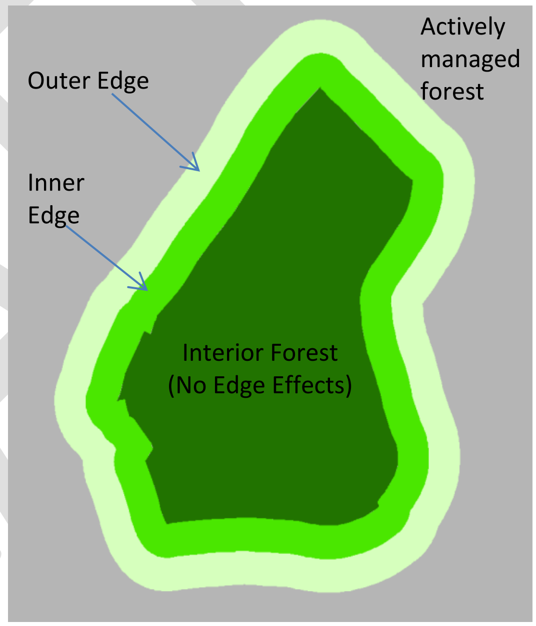
How does LTFC provide nesting security to murrelets?

LTFC is assumed to conserve habitat by protecting current and potential nest sites from harvest and other land uses in the managed forest. The shape and amount of *interior forest* patches within LTFC is a critical factor in nesting success and security. *Forest edges* created from harvest or other types of openings (e.g., roads) impact this security. LTFC can be classified into one of three forest zones that support varying levels of marbled murrelet conservation. These zones are influenced by the condition of the adjacent managed forest, which is characterized as “hard-edged,” “soft-edged,” or in a “no-edge” state. In addition, some areas, referred to as riparian “stringers” (see below), are linear in nature and do not include any interior forest. Beyond these areas is the actively managed forest, where most of the harvest and related activities occur.

Interior forest

The *interior forest* (Figure 2) is comprised of forested area (patch) that is at least 100 meters from any type of edge. These interior areas are protected from effects associated with harvest edges. Edge effects include changes in microclimate (such as decreasing humidity), windthrow, changes in vegetative species such as reduction in epiphyte presence, and increased risk of predation (Nelson and Hamer 1995; McShaneand others 2004; Van Rooyen and others 2011). Further, impacts to murrelets from disturbance (loud noise and activity that can interrupt breeding and nesting behaviors) is reduced in the interior forest portions of LTFC. (See Focus Paper #5, “Potential Impacts and Mitigation,” for a detailed description of edge effects.)

Figure 2. Conceptual Illustration of an Area of LTFC and Edges



Outer edge

The *outer edge* of the interior forest patch is located between 0 to 50 meters from the edge of managed forest (Figure 2). Because this area is adjacent to the actively managed forest, edge effects are more pronounced in the outer edge.

Inner edge

The *inner edge* (Figure 2) is a forested area located 51 to 100 meters from the edge of the actively-managed forest, and is adjacent to the interior forest patch. The literature indicates that the edge effects from the actively managed forest extend further than 50 meters into the stand, but diminish until there is minimal effect after 100 m from the managed area (Burger and others 2004).

Hard-, soft- and no edges

Depending on the age and height of the trees in the actively managed forest, edges can be characterized as either “hard” or “soft.” Hard edge effects extend through the outer and inner edges, and occur when the actively managed forest is comprised of young stands (0-20 years old) that are expected to be generally less than 40 feet high. Higher risk of nest predation, and increased microclimate and windthrow effects are all associated with hard edges.

Soft edges are characterized by managed forest stands that are expected to be generally 20-40 years old and 40-80 feet high adjacent to the long-term forest cover.[9] At this stage, interior forest and the outer and inner edges are less affected by predation risk and microclimate and windthrow effects still factor into edge impacts, but to a lesser degree. Trees in the managed forest that are beyond 40 years of age and 80 feet in height are assumed to have minimal edge effects to the interior, and therefore are not counted as edge under the analytical framework.

DNR can assess the edge conditions of managed forest lands in the analysis area using forest inventory and GIS data. This information is used to determine potential impacts to murrelet habitat from forest edges, and to calculate necessary mitigation (see Focus Paper #5, "Potential Impacts and Mitigation.")

Roads as edges

New and existing forest roads (logging roads) also create edges. Depending on their location relative to murrelet habitat, and whether they are actively used or are undergoing transition back to forest, roads have effects similar to other hard or soft edges. Roads can attract corvids and affect microclimate. (See Focus Paper #5, "Potential Impacts and Mitigation," for a discussion on how roads and other edges impact habitat and mitigation values.)

"Stringers"

Areas mapped as long-term forest cover using GIS will show large and small blocks of LTFC, as well as some narrow strips of land. These narrow strips are termed "stringers," and are predominantly riparian management zones. Stringers are areas less than 200 meters wide and therefore do not have interior forest. Stringers are considered part of LTFC; however, they may not be assigned credit for mitigation under the conservation alternatives.

Areas outside LTFC

Forest land outside of LTFC is managed for harvest to meet fiduciary responsibilities to DNR's trust beneficiaries. These are part of the actively managed forest.

How does LTFC differ across the conservation alternatives?

DNR and the U.S. Fish and Wildlife Service are developing alternative approaches to long-term marbled murrelet conservation. These alternatives will be evaluated using a common analytical framework.[10]

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[9] Note that the tree height and age associations described here are generalized, and may vary somewhat across the landscape depending on site conditions.

[10] See Focus Paper #1, "Analytical Framework."

Designating areas of LTFC under each alternative allows potential impacts to be quantified, mitigation to be calculated,[11] and conservation benefits to be evaluated. The amount and composition of LTFC varies among alternatives (see Figure 3 for an example). The proportion of interior forest to outer and inner edges may vary, or the occupied sites or conservation areas that are included may be different.

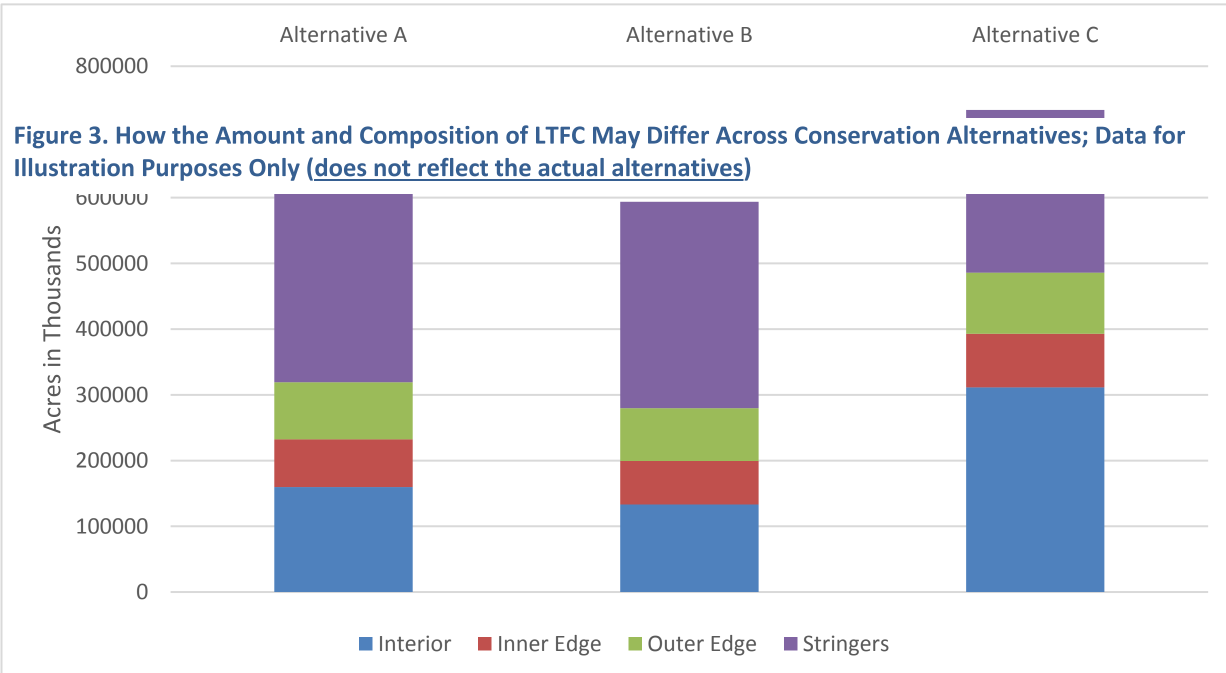

Figure 3. How the Amount and Composition of LTFC May Differ Across Conservation Alternatives; Data for Illustration Purposes Only (<u>does not reflect the actual alternatives</u>)

These differences in composition mean that the geographic extent of LTFC (how much of and where on the landscape it is located) will differ among alternatives. All LTFC is intended to provide conservation benefit to the murrelet. However, the conservation value of one area of LTFC may be higher or lower than another, depending on its relative habitat quality, its location relative to occupied sites or marine populations, and other factors. The analytical framework takes these factors into account when calculating potential impacts and mitigation through the life of the HCP.

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[11] See Focus Paper #5, "Potential Impacts and Mitigation."

How will areas of LTFC be managed for purposes of marbled murrelet conservation?

Stands within interior areas of LTFC that have marbled murrelet habitat characteristics, or that have the potential to develop those characteristics, will be protected from potential impacts from harvest, edge effects, and other types of disturbance.

Although the exact make-up of LTFC may differ among conservation alternatives, the management objective of LTFC is the same under every alternative: to provide long-term forest cover. Forest stands within areas of LTFC that have murrelet habitat characteristics, or that have the potential to develop murrelet habitat characteristics, will be conserved over the life of the HCP. No major harvest activities will be allowed within LTFC. The conservation alternatives being developed may allow some thinning or habitat enhancement within areas of LTFC, consistent with the underlying conservation objectives. For example, riparian areas within LTFC may be thinned consistent with DNR's Riparian Forest Restoration Strategy. Management of non-timber harvest land uses will also be addressed under the alternatives.

Management will be consistent with the conservation objective that the quality and quantity of habitat within areas of LTFC is expected to improve as forest stands mature. Mature stands that do not currently have murrelet habitat characteristics will also have the potential to develop into habitat over the life of the HCP.

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Appendix H. Potential Impacts and Mitigation Focus Paper

Potential Impacts and Mitigation

Focus Paper #5

This focus paper was part of a series presented to the Board of Natural Resources in October and November 2015 to inform development of the marbled murrelet long-term conservation strategy alternatives. The purpose of this paper is to describe how possible impacts to murrelet habitat from harvesting, edge effects and disturbance activities on DNR-managed lands are assessed and mitigated across conservation alternatives.

Introduction

The analytical framework (see Focus Paper #1) identifies three sources of possible impacts to marbled murrelets that may incidentally occur on state-managed lands: harvest-related impacts, edge-influenced impacts and disturbance-related impacts. These impacts can be quantified using repeatable, objective methods based on sound science. By doing so, these impacts can be evaluated against the minimization and mitigation proposed under each alternative being developed for the long-term marbled murrelet conservation strategy.[1]

Quantifying impacts and mitigation

Quantifying impacts to marbled murrelet habitat and determining mitigation hinges upon identifying and assigning value to habitat. The value of habitat is related to its likelihood of use

[1] As defined in the HCP, mitigation "includes methods to reduce adverse impacts of a project by (1) limiting the degree or magnitude of the action and its implementation; (2) rectifying the impact by repairing, rehabilititating, or restoring the affected environment; (3) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action, or; (4) compensating for the impact by replacing or providing substitute resources or environments."

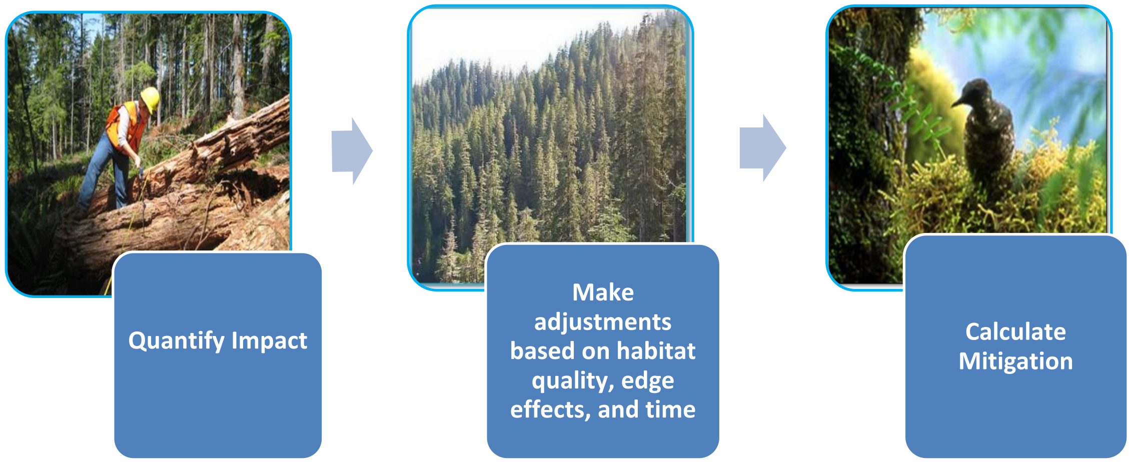


Figure 1. Conceptual Steps in Quantifying Impacts and Mitigation

by murrelets, and generally increases with age and structural complexity of the forest.[2] Because not every acre of habitat is of equal value to the murrelet, it is important that the varying weights of impact or mitigation provided by each acre are quantified appropriately.

Harvest impacts and mitigation

Harvest impacts include activities such as timber harvest or road building that result in the removal of marbled murrelet habitat (acres with P-stage values). These activities primarily occur in the managed forest, outside areas of long-term forest cover (see Focus Paper #2, "Areas of Long-Term Forest Cover"). Removing habitat can result in the loss of existing nests and reduce future reproductive capability, therefore impacting the species. The analytical framework provides a methodology to assess harvest impacts to potential marbled murrelet habitat over the life of the HCP.

For analysis purposes, the framework assumes that the loss of habitat from harvest in the managed forest over time will be offset by habitat gains that occur in areas protected by the conservation strategy. Each habitat acre harvested and each acre grown have different habitat *values*, depending on their P-stage value, their location relative to forest edges (decribed below), distance from other habitat areas, and in which decade they are harvested or develop into habitat.

[2] See Focus Paper #3, "Estimating the Location and Quality of Stands of Marbled Murrelet Habitat." *Note: This paper will be available in late November 2015.*

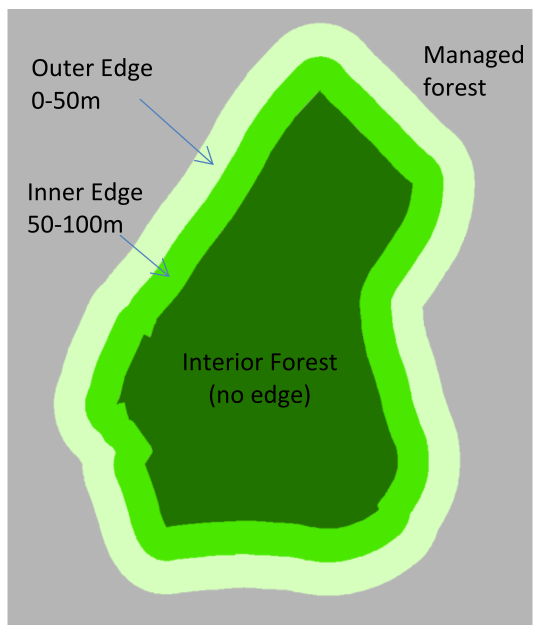
Table 1. Simplified Calculation of Harvest Impacts and Mitigation

Acres Harvested		Habitat Value		Mitigation Acres Needed
500	X	.36	=	180

The equation in Table 1 is simplified. Calculating the value of the habitat is a more complex process that includes the P-stage value plus other factors influencing a forest stand's value as murrelet habitat. These factors include whether the acres are in an edge condition, where they are located on the landscape, when the harvest and/or new habitat development occurs, and whether the habitat is subject to disturbance. These factors are discussed in detail, below.

Edge impacts

Figure 2. Illustration of Forest Edges



A forest edge is an abrupt transition between two populations of trees, where the characteristics of the forest on one side are different from the other. Some edges are naturally occurring, created by wetlands, streams, or avalanche chutes, and others are created through human activity. Timber harvesting can create a high contrast edge along the boundary between the harvested area and the adjacent forested stands. Exposed harvest edges alter microclimate effects (light, moisture, wind, and temperature gradients) in adjacent stands for distances of up to 240 meters (787 feet) (Chen and others 1993, p. 291, 1995, p. 74). For this analysis we use a distance of 100 meters (328 ft) to account for the most significant physical and biological effects to murrelet habitat along harvest boundaries due to the loss of trees to windthrow, loss of moss for nesting substrate, reduced canopy cover, altered forest composition, and increased risk of nest predation (Chen and others 1992, pp. 390-391, van Rooyenand others 2011, p. 549, Raphael and others 2002, Malt and Lank 2009, p. 1274). For purposes of analyzing edge effects, we distinguish between an outer edge (the first 50 meters from an edge) and inner edge (50-100 meters from an edge). See Figure 2.

How do edges impact murrelet habitat?

Timber harvest edges can influence adjacent murrelet habitat in two ways: through increased risk of nest predation and habitat degradation resulting from windthrow and microclimate changes. Edge effects resulting from timber harvest may increase the risk of marbled murrelet nest predation in habitat located close to unnatural edges (harvest edges and major road corridors). A review of known murrelet nests found average nest success was 38% within 50 meters (164 feet) of a forest edge, and 55 % at distances greater than 50 meters from an edge. Most nests failed because of predation (60%), and predation was higher within 50 meters of an edge than within the forest interior. No murrelet nests greater than 150 meters (492 feet) from an edge failed because of predation (Manley and Nelson 1999, McShane and others 2004, p. 4-89). Based on these data from actual murrelet nests, the average nesting success rate within 50 meters of an unnatural edge is 69 % of nests located greater than 50 meters from an edge.

Predator populations are in highest abundance along forest edges bordered by newly initiated stands.

Observations at known nests are affirmed in other research studies that examined the fate of simulated murrelet nests relative to forest edges and stand structure (Raphael and others 2002, Malt and Lank 2009). Simulated murrelet nests located within 50 meters (164 feet) of high contrast edges created by recent timber harvest are 2.5 times more likely to be disturbed by predators relative to nests located in adjacent interior forest (Malt and Lank 2009, p. 1274). The increased predation risk is associated primarily with Steller's jays (*Cyanocitta stelleri*) because they are habitat generalists that respond positively to forest fragmentation and preferentially use forest edges due to the abundance of berries and insects in young regenerating forests (Malt and Lank 2009, pp. 1283-1284). Predation risk associated with harvest edges declines over time (20 to 40 years after timber harvest) as young forests regenerate and become dense, simple-structured stands with no understory (Malt and Lank 2009, p. 1282).

Edge effects also increase windthrow and alter microclimate regimes, both of which impact murrelet habitat. Van Rooyen and others (2011) analyzed platform abundance, epiphyte growth, and microclimate at forest edges to understand edge effects on murrelet habitat. In "outer edge forest," which the authors define as 0-50 meters from an edge, they found platform abundance adjacent to regenerating forest (a "hard edge," approximately 0 – 20 years old) was reduced by 75% in comparison with interior forest. Platform abundance at "soft edges" (young forest stands approximately 21 to 40 years old) was only 60% of the abundance found in interior forests.[3] Reductions in platform abundance at these various-aged edges were attributed to the loss of

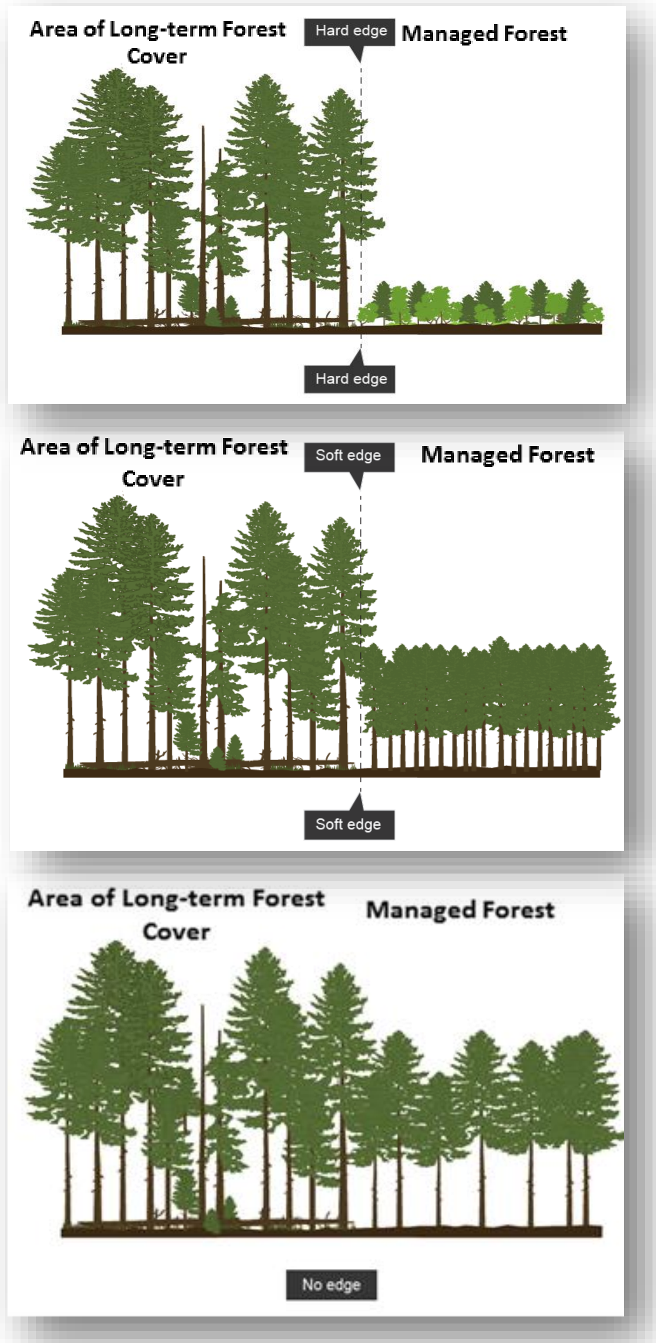
[3] Table 4 in van Rooyen and others 2011; authors found a mean of 16.02 ± 5.14 platform trees at soft edges, as opposed to 26.8 ± 6.60 platform trees in interior forests (16.02 divided by 26.8 equals 60%).

platform-bearing trees from windthrow and other mortality sources, and to microclimatic effects that diminished epiphytic growth important to development of potential nesting platforms. The lesser effects at soft edges suggests that epiphyte growth is recovering from the hard edge impacts and is contributing more towards platform development.

How far into the forest do the edge effects occur?

The extent of influence regarding microclimate and epiphyte effects into stand interiors has not been well studied, but evidence from a study in western Washington and Oregon old-growth forests that looked at 0, 30, 60, 120, 180, and 240 meters suggests appreciable tree mortality decreased substantially beyond 120 meters from edges (Chen and others 1992). Edge effects diminish with increasing distance from a hard edge. We selected 100 meters to represent the suite of edge effects (predation, habitat degradation, and windthrow). Recognizing that effects diminish with distance from the edge, we assumed that "inner edge" effects are half relative to those in the outer edge.

Figure 3. Edges Change with Forest Succession



How does forest succession influence edge effects?

Studies have shown that forest edge effects diminish over time, as harvest areas regenerate and develop into mature forest stands (Matlack 1993, Harper and others 2005, cited in Van Rooyen 2012; see Figure 3). Early stages of stand development following harvest, referred to as *ecosystem initiation*, are characterized by actively growing young trees and other herbaceous vegetation (DNR 2007).

With their rapidly growing vegetation and increasing forage base (e.g., insects, berries), ecosystem initiation stands provide a wide range of food sources and more opportunities for foraging to predators, particularly Steller's jays, a known predator of marbled murrelets (McShane and others, 2004).

Over time, the vegetation in the ecosystem initiation stand fills the available growing space and the stand develops into a *competitive exclusion* stage, characterized by more than 70% canopy cover and simpler stand structure. Stands in these stages have the lowest biodiversity and the least favorable conditions for wildlife when compared to all the stand development stages (DNR 2007). In competitive exclusion, fewer microhabitats for foraging are available for the predators(McShane and others 2004). As predation decreases, however, microclimate effects and windthrow continue to impact adjacent habitat by allowing sunlight and wind into the adjacent marbled murrelet habitat. We estimate that once stands on DNR managed lands reach a height of 40 feet, they have reached the beginning stages of competitive exclusion.

When adjacent forests reach 80 feet in height they are assumed to ameliorate edge effects, for the purposes of this analysis (Malt and Lank 2009, Van Rooyenand others 2011). Once stands achievesthis height, the crowns begin to overlap with the those of the stand containing murrelet habitat, diminishing the impacts resulting from altered climatic regimes and windthrow.

How does the analytical framework address edge effects?

The analytical framework adjusts the mitigation value of habitat located in the edges of long-term forest cover to account for the edge effects that will impact that habitat over the life of the HCP. The adjustment factors are based on proximity to habitat (inner or outer edge) and edge condition (hard, soft or no edge).

Both edge location (inner or outer) and edge condition (hard, soft, or no-edge) play a role in determining edge effects.

The analytical framework categorizes edge conditions into three groups: hard, soft, and no edge. Newly initiated stands adjacent to the mature forest containing murrelet habitat are considered to create “hard edge” where their height is 40 feet or less (see Figure 3 and Figure 4). Stands in competitive exclusion adjacent to a mature forest containing murrelet habitat are considered to create “soft edge” where their height is between 40 and 80 feet. Finally, stands with a height greater than 80 feet adjacent to a mature forest containing habitat are not considered to be “edge-creating;” as they have a diminished effect on the adjacent habitat compared to hard edges

Figure 4. Example of Hard Forest Edge Created by Harvest

Edge conditions are not static over time; they change as forests regenerate. The relative percentages of edge across DNR-managed lands will, however, remain generally similar throughout the life of the HCP. This is because DNR will continue to manage its forest consistent with its policies, continuing the pattern of sustainable harvest in portions of the analysis area while leaving the LTFC portion to develop mostly without direct management intervention.

How are edge effects quantified?

There are two adjustment factors are used in the analytical framework to address edge effects – one that is applied to outer edge and another applied to inner edge. When applied, these factors adjust the value of habitat *down*, reflecting the edge effect.

First, discounts are applied to habitat in a particular edge condition based on the scientific information about how that condition impacts murrelet nest success. No discounts are assumed for interior forests (forests in a “no-edge” condition).

For forests in the outer edge (Table 2), these impacts are:

- Hard, Outer Edges: predation, microclimate, and windthrow;
- Soft, Outer Edges: microclimate only.

Table 2. Outer Edge Effect					
Forest Inventory Data-Derived Edge Condition[a]			**Discount Multiplier**		**Outer Edge Factor**
Hard	21%	x	.83[b]	=	.174
Soft	33%	x	.40[c]	=	.132
No-Edge	46%	x	0[d]	=	0
			Sum	=	**.31**

[a] Percentages are presented here and in Table 3 as an example. Each alternative conservation proposal will have different percentages, due to differences in the amount and configuration of LTFC.

[b] Van Rooyen and others (2011) found that platform tree density at hard edges is 25% of the density found in interior forests. McShane and others (2004) summarized from different sources that nests at hard edges are 69% as successful as nests in interior forests. When combined (.25 x .69 = .17), an 83% discount results for this edge condition.

[c] Microclimate conditions in soft, outer edges result in only 60% of the platform density relative to interior forests (Van Rooyen and others 2011). Therefore, a 40% discount is applied.

[d] No edge discounts are assumed.

For forests in the inner edge (Table 3), only microclimate impacts (not predation), are considered, as follows:

- Hard, Inner Edges: microclimate (not predation)
- Soft, Inner Edges: microclimate, but at half the intensity as a hard edge.

Table 3. Inner Edge Effect					
Forest Inventory Data-Derived Edge Condition			**Discount Multiplier**		**Inner Edge Factor**
Hard	21%	x	.415[a]	=	.09
Soft	33%	x	.20[b]	=	.07
No-Edge	46%	x	0[c]	=	0
			Sum	=	**.15**

[a] Only microclimate, not a combination of predation and microclimate, is assumed to be a factor in inner, hard edges. So half of the discount applied to outer edges (.83/2).

[b] Microclimate conditions in soft, inner edges are assumed to be half of those in outer edges (.40/2).

[c] No edge discounts are assumed.

The resulting edge factors are then multiplied against the number of P-stage acres in each edge condition to derive the total potential take from edge effects. Because each alternative being developed for the long-term conservation strategy has a different amount of long-term forest cover, and in different configuration on the landscape, the resulting calculations and edge factors differ slightly across the alternatives.

Disturbance impacts

In addition to harvest and edge impacts, forest management activities can impact murrelets by creating unfamiliar sights and sounds that may disturb them. This can be disruptive to murrelets during their nesting season when they are incubating eggs and caring for their young. The analytical framework refers to impacts that result from activities that create these audio and visual stimuli as *disturbance impacts*. Quantifying disturbance impacts requires a different approach, because unlike harvest or edge impacts, the vegetation within habitat is not altered through removal or degradation. Instead the environments within habitat are temporarily altered, with the impact of possibly interrupting the murrelet nesting behavior. In addition, some activities occur repeatedly during the nesting period. To quantify potential disturbance impacts, the analytical framework estimates the magnitude and frequency of all activities with the potential to disturb murrelets during the nesting season.

What are disturbance impacts?

A disturbance event is considered significant when an activity causes a murrelet to delay or avoid nest establishment, flush away from an active nest site, or abort a feeding attempt during incubation or brooding of nestlings. A flush from a nest site includes movement out of an actual nest, off of the nest branch, and away from a branch of a tree within suitable habitat during the nesting season. Such events are considered significant because they have the potential to result in reduced reproduction, hatching success, fitness, or survival of juveniles and adults (USFWS 2012).

What activities can disturb murrelets?

When evaluating the potential for audio-visual disturbance of nesting murrelets, DNR and USFWS grouped activities into three categories:1) aircraft , 2) ground-based activities, and 3) impulsive noise-generating activities such as blasting and pile-driving. Aircraft activities includes any forest management activity that requires the use of low-flying, small fixed-wing planes and small helicopters, such as aerial spraying of herbicide treatments. Examples of ground-based activities include timber harvest and hazard tree removal, and road and trail matinenance. Activities generating impulsive noise include blasting to generate rock for forest roads.

How are disturbance events evaluated?

It is very difficult to separately analyze an animal's response to either auditory or visual stimuli alone (Pater and others 2009), and most studies have not been designed to adequately control for those factors separately. As such we evaluate both the audio and visual component of potentially disturbing activities together.

The body of knowledge on bird response to disturbance indicates that human activity can potentially impact nesting success and can be energetically costly to individual birds. Disturbance can have effects throughout the nesting season, including the nest establishment, incubation, and chick rearing phases. Marbled murrelet response to disturbance is variable and appears related to the developmental stage of the individual bird exposed to stimuli, degree of habituation existing prior to exposure, and whether there is a visual component to the stimuli. Murrelets have responded behaviorally to disturbance in ways that create a reasonable likelihood of injury to the adult, the chick, or both.

How far from murrelet habitat can activities disturb murrelets?

In a review of best available information on avian ecology, disturbance, and acoustics, USFWS determined that significant disturbances to murrelets can occur within a distance of 100 meters of suitable habitat throughout the murrelet nesting season (USFWS 2012a). Exceptions include blasting, (0.25 mile-radius disturbance distance), and large aircraft (e.g., military jets) where the disturbance distance is defined by where the sound exposure level (SEL) from the aircraft meets or exceeds 92 dBA (A-weighted decibels).

What time of year can murrelets be disturbed?

The USFWS has previously determined that murrelets can be disturbed during their nesting season, which occurs between April 1st and September 23rd, 176 days out of the year. There is enough overlap in nest establishment, incubation and nestling periods to assume there is equal risk of murrelet exposure to disturbances occurring throughout the nesting season (USFWS 2012b).

How do murrelets respond to these disturbances?

Murrelet responses are expected to vary according to the type of activity in combination with the timing, duration, and frequency of the exposure. Many forest dwelling birds (including raptors, golden eagles, and Mexican spotted owls) exhibit increased flush rates due to noise. Chicks and adults are expected to vary in their response. Observations by murrelet researchers in the field indicate that murrelet chicks may not have a noticieable response to noise and visual stimuliat all, or may respond by becoming very still, lying flat on the branch (Hebert and others 2006). As such, murrelet chicks are not expected to prematurely leave a nest in response to these types of noise and visual stimuli. However, adult murrelets may abandon or delay nest establishment, or abort or delay feedings in response to exposure to these stimuli. Adults that are inclubating an egg are not expected to flush (USFWS 2012a).

How does the analytical framework evaluate the significance of each activity?

Disturbance is quantified by determining the the birds' likely response given the duration and intensity of a stressor and converting that information into acres

The HCP permits a range of forest management activities. The analytical framework relies upon an analysis of all activities permitted to occur on DNR-managed lands to determine whether they have the potential to cause disturbance to marbled murrelets. The framework identifies 36 activities that may cause disturbance. Examples include:

- Recreational site use
- Sand and gravel sales
- Electronic site maintenance
- Road use and maintenance
- Collection of western greens, Christmas greens, and mushrooms.

In order to quantify the potential impacts that result from these activities, the analytical framework assigns values for the following qualities that are used to measure the significance of the disturbance activities: stressors, duration, and response. Disturbance is quantified by determining the birds' likely response given the duration and intensity of a stressor and converting that information into acres of habitat exposed.

Stressors are physical, chemical, or biotic phenomenon or a circumstance that constitutes a real or perceived challenge or threat to an organism's physical health, homeostasis, or homeostatic mechnisms. Stressors include:

- Ground-based noise (examples: chainsaws that are harvesting trees, removing hazard trees from campgrounds, or heavy equipment maintaining roads);
- Visual disturbance (example: human presence around nest trees, such as someone hiking around or near a nest tree);
- Human activity that attracts predators (example: campgrounds close to murrelet habitat, because the human activity draws the predators to the habitat);
- Impulsive noise (example: blasting in rock pits to generate crushed rock for forest roads)
- Aircraft noise (example: sounds generated by helicopters and small planes).

Duration represents the length of time an activity is present within close proximity of murrelet habitat. Duration measures how long the habitat would it be exposed to that activity. Duration categories include:

- <1 day
- <7 days
- >7 days and < 30 days
- >30 days

Response represents the murrelet's possible behavioral reaction to various auditory and/or visual disturbances. Responses include:

- No significant response
- Aborted feedings
- Adults flushing
- Mortality or loss of productivity from removal of nest tree
- Mortality from predation
- Hearing damage.

How does the analytical framework evaluate disturbance?

Once each activity is assigned stressor, duration and response the activities are allocated into six groups based on similar combinations of these three categories (see Table 4). For each group, the analytical framework estimates the total habitat area within the appropriate distance bands of each activity (100 meters of each ground-based and small aircraft activity and ¼ mile for blasting) and then adjusts the acreage for habitat quality, time of year that the activity occurs, and then by the total years remaining in the HCP.

Table 4. Activity Groups by Stressor, Distance, Duration, and Response

Group Assignment	Stressor	Disruption Distance	Duration	Response/Impact
Group 1 (includes green collecting, precommercial thinning, non-motorized trail use, minor road maintenance)	Ground-based Noise and Visual Disturbance	≤100 m	< 1 Day	No significant response based on duration; minimal to no impacts
Group 2 (includes firewood collection, road reconstruction, major road and trail maintenance, communications facilities)	Ground-based Noise and Visual Disturbance	≤100 m	< 7 Day	Aborted feedings, Adults flushing; potential harassment[1]
Group 3 (campground use and maintenance)	Ground-based Noise and Visual Disturbance Predator Attraction	≤100 m	< 1 Month	Increased predation risk, Aborted feedings, Adults flushing; potential harm[2]
Group 4 (includes timber harvest, motorized trail use, new road and bridge construction)	Ground-based Noise and Visual Disturbance	≤100 m	>7 Days < 1 Month	Aborted feedings, Adults flushing; potential harassment

Group 5 (sand and gravel extraction, blasting)	Ground-based Noise and Visual Disturbance	≤.25 mi	>7 Days < 1 Month	Hearing damage from blast noise (within 100m), Aborted feedings, Adults flushing; potential harm or harassment
Group 6 (aerial herbicide application)	Aircraft Noise	≤100 m	< 7 Days	Aborted feedings, Adults flushing; potential harassment

[1]Harass is defined as an act which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly impair normal behaviors, including breeding, feeding, or sheltering (50 CFR 17.3).

[2]Harm is defined as act which actually kills or injures wildlife, and can include habitat modification that significantly impairs essential behaviors such as breeding, feeding, or sheltering (50 CFR 17.3)

When estimating possible responses of the marbled murrelet to human activity, it is important to note that empirical data are lacking for the range of activities represented in Table 4. Studies evaluating the effects of noise on various animals frequently use different metrics, and often fail to report which metrics they use, making comparisions and interpretation difficult. For the pursposes of this analysis, we do not expect that short-term exposures to low intensity stimuli that last less than 1 day will adversely effect marbled murrelets. However, any reduction in feedings has the potential to physiologically effect a murrelet chick, depending on how many feedings are received in one day, and presumably, the energy content of the food that is delivered. Further, aborted or delayed feedings have the potential to increase energy demands and predation risk on adult murrelets. Conversely, when weighing these risks, we must also consider that many of these short duration activities are intermittent and low intensity (e.g. mushroom pickers walking through a stand of suitable habitat) and pose little risk. After considering these factors, we expect that exposure of juvenile and adult murrelets to these low-intensity activites, when lasting <1 day are not expected to result in measureable effects, and are therefore insignificant.

Adjusting disturbance impacts for habitat area, quality and time

Using DNR's GIS and other data, including annual activity reports and summaries, the analytical framework identifies the *footprint* of each activity within each group, as it occurs on DNR-managed lands within the range of the murrelet. Using a distance buffer with a width equivalent to the area of disturbance around the footprint, the framework sums the total area of P-stage habitat for each activity. These totals are then summed for each group.

The analytical framework only quantifies disturbance for the habitat located within LTFC. This is because we assume that habitat located outside of LTFC will be removed over time, therefore the expected disturbance impacts in managed areas are accounted for in the harvest impact estimates. The P-stage acreage is multipled by the proportion of DNR-managed lands within LTFC to reflect the habitat acres disturbed within LTFC by each group.

As with edge effects, the effects of disturbance vary based on the *quality* of habitat (P-stage value). Therefore, in evaluating disturbance take, acres of disturbed habitat are multiplied by their P-stage value. (See Attachment 1 for an example of how this works.)

The magnitude of disturbance impacts are also influenced timing; by *when* they occur in a particular year and *how often* throughout the year. This is because activities that disturb marbled murrelets impact their reproductive activities, such as nest incubation, caring for young, which only occur during the nesting season. This analysis is limited to the time period of the murrelet nesting season, when impacts to reproduction are most likely to result.

Timing is considered in two dimensions: the time of year (i.e., marbled murrelet nesting season or not; and if so, how many days) and the duration of the activity during the week (i.e., occasional versus everyday occurrence, or a 5-day workweek occurrence).

To factor time adjustments into the estimate of disturbance impact, the framework multiplies the weighted habitat acres in LTFC by the number of days the activities within each group overlaps with the nesting season. The number of days the activities overlap with the nesting season is influenced by how often an activity occurs during the week. For example, road maintenance on DNR lands is expected to only occur 5 days a week, whereas campground use may occur on weekdays or weekends throughout the summer. The result is an adjusted number of acres potentially affected by disturbance activities during the nesting season.

Some of these habitat acres will be disturbed repeatedly over the life of the HCP. To account for this, the framework takes the time-adjusted weighted habitat acres and multiplies them by the years remaining in the HCP (52 years), for a final amount of statewide time-adjusted acres of P-stage habitat in LTFC disturbed during the nesting season. This final acreage calculation is an estimate of DNR's potential disturbance impact. An example of how these adjustments work is provided as Attachment 1.

Where will mitigation occur?

DNR's conservation strategy uses areas of *long-term forest cover* to provide both minimization and mitigation for the types of impacts described above.[4] Areas of long-term forest are established to meet a variety of conservation objectives but within the murrelet conservation strategy they serve three major purposes:

1) To conserve most marbled murrelet habitat on DNR-managed forest lands;
2) To minimize overall impacts to that habitat and increase its quality by including additional contiguous area to increase the area of interior forest habitat;

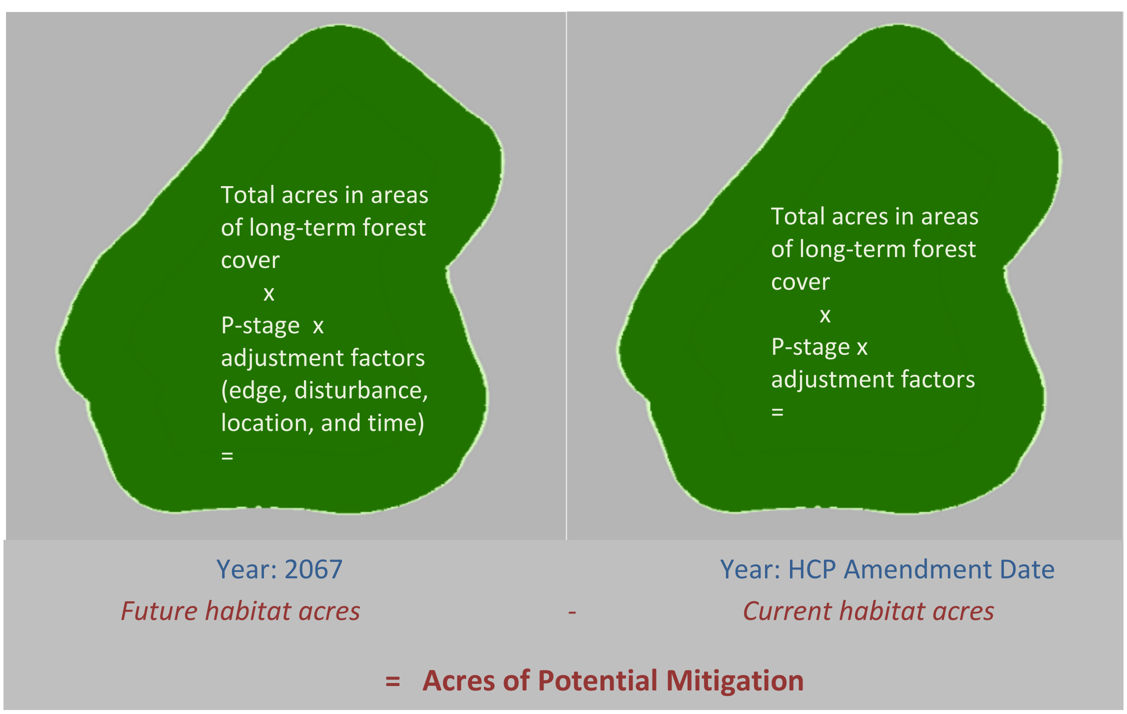
[4] See Focus Paper #2, "Areas of Long-Term Forest Cover."

3) To mitigate impacts from activities in the managed forest by allowing new and higher quality murrelet habitat to develop through time.

Similar to how impacts are adjusted for edge conditions and other factors, adjustments must be made to the mitigation value of habitat grown over the life of the HCP. Mitigation provided by LTFC can be expressed as the number of acres of marbled murrelet habitat grown within those areas through the end of the HCP. Mitigation value is determined by subtracting "current habitat acres" from "future habitat acres." See Figure 5. The total acres of P-stage habitat located inside and out of areas of long-term forest cover varies across conservation alternatives, depending on what is included LTFC (size of the conservation areas, occupied site buffer widths, and other landscape components). For each alternative, this habitat can be quantified. Total "raw" acres of habitat with P-stage values are estimated using DNR's inventory information of forest lands. The total "raw" acres within each P-stage category (.25, .36, .47, .62, .89, 1.0) are then multiplied by their respective values. These raw acres are converted to "weighted habitat acres," which incorporates habitat quantity and quality, including edge effects, into one unit. All of the totals are summed, producing the total "current habitat" for each alternative.

When the acres of habitat are multiplied by their respective P-stage value and other adjustment factors, the total acres in that category that can be used as mitigation is reduced, according to quality. For example, if 100,000 acres of LTFC only has a P-stage value 0.25, this is valued as 25,000 acres for purposes of calculating mitigation.

Figure 5. Calculating Mitigation in Areas of Long-Term Forest Cover



Not all habitat is considered for mitigation

An *interim strategy* for marbled murrelet conservation has been operating since the HCP was adopted in 1997. This strategy included protections for occupied sites and reclassified habitat (see focus paper #3, "Occupied Sites"for a brief description of the interim strategy)[5]. USFWS issued an incidental take permit for impacts to the murrelet occurring on DNR's managed forest lands over this time period, and DNR has complied with that permit. Habitat has also been growing and developing for the murrelet during this time. However, no mitigation credit will be given for that interim habitat development because this analysis starts with current conditions. The analytical framework is forward-looking. It begins in "Decade 0" (current year until 2025) and focuses on potential impacts and mitigation occurring out to 2067 ("Decade 5"). Habitat is expected to increase within areas of long-term forest cover through that time period.

In addition, the analytical framework does not give credit to forest stands within LTFC that do *not* have a P-stage value; stands that are too young to count toward total acres of habitat. These stands may still have conservation value for the murrelet by reducing fragmentation.

Adjusting mitigation values for time

Adjustments to the mitigation value of habitat are necessary to accommodate edge and disturbance effects, as described above. However, a different kind of adjustment is needed to address another modifier of habitat quality: time. Habitat that exists today currently provides nesting opportunities to murrelets and is therefore more valuable than habitat that will be developed further into the future (as forests mature). If an impact to that habitat happens today, the offsetting mitigation (the same value of habitat becoming available to the murrelet) may not happen for several years. The analytical framework takes this into account by adjusting the value of mitigation through time, which is expressed by decade to the end of the HCP.

The decadal adjustment factor is based on how much habitat develops in a particular decade, as well as which decade that habitat is realized. For example, the total habitat that develops in long-term forest cover from the present into the first decade receives full mitigation credit to offset harvest in the managed forest within that first decade; all of the acres are counted. However, the total habitat that develops between the first and second decades receive only 80% of the total credit. This is because the habitat that grows during this decade will contribute to murrelet conservation for less time, four out of the five total decades (4/5 = 80%). Growth occurring between the second and third decades receives 60% credit (three out of five decades of growth), and so forth through to the end of the HCP. (See Table 6, below.)

[5] *Note: This paper will be available in late November 2015.*

Table 6. Adjusting Future Habitat in Mitigation Value. Numbers are for illustration purposes only. They are not a representation of DNR-managed lands.

Decades	Habitat Acres	Difference Between Decades	Decade Adjustment Factor	Acres of Mitigation Credit
0	1000			
1	2000	1000	1.00	1000
2	3000	1000	0.80	800
3	4000	1000	0.60	600
4	5000	1000	0.40	400
5	6000	1000	0.20	200
		Total Mitigation Credit:		**3000**

Adjusting mitigation values based on location

Across the analysis area, some landscapes are less valuable, or "marginal" for long-term marbled murrelet conservation due to a lack of suitable habitat, isolation from known occupied sites, and low-capability for developing future habitat based on forest types. An example of a marginal landscape for marbled murrelets is the Capitol Forest, located in the South Puget Planning Unit. The Capitol Forest is a large landscape that encompasses more than 95,000 acres of DNR-managed lands, but currently contains relatively little murrelet nesting habitat (< 2,000 acres). DNR conducted marbled murrelet surveys at more than 450 survey stations located within the Capitol Forest. Murrelet presence was detected at only one survey station, and no murrelet occupancy behaviors were detected during any of the surveys. The Capitol Forest has been intensively managed for timber production for many decades, and is comprised of forest dominated by second-growth Douglas-fir plantations which have a low capability to develop into murrelet habitat during the life of the HCP. Due to the limited and fragmented nature of potential nesting habitat in this landscape, and no known occupied murrelet sites, we consider the Capitol Forest to be a marginal landscape for murrelet conservation.

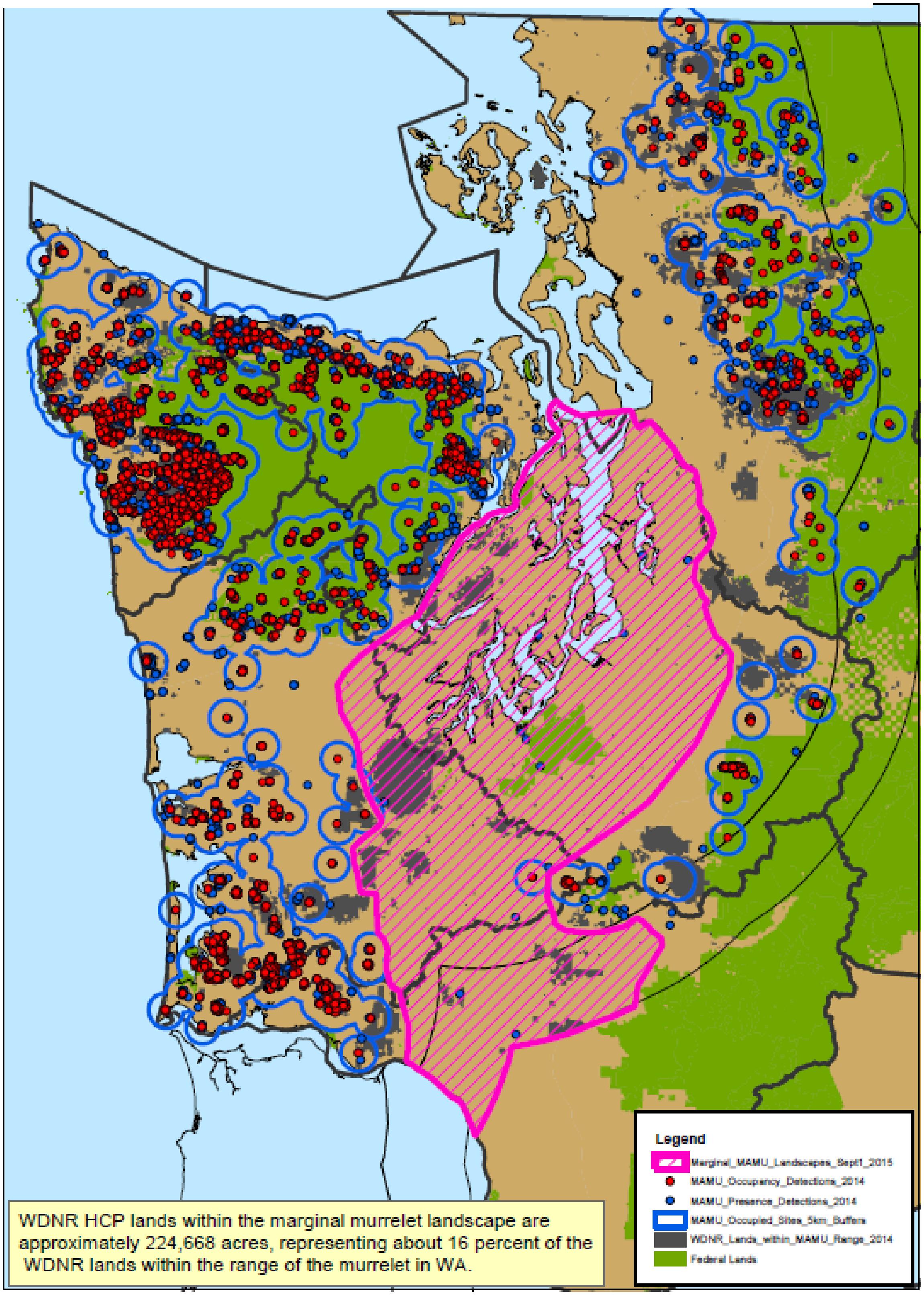
To define marginal murrelet landscapes we considered multiple factors:

- proximity to known occupied sites (within a distance of 5 km from known occupied sites[6]),
- results of marbled murrelet survey information,
- proximity to murrelet critical habitat on federal lands,
- current habitat distribution, and
- capability for developing future habitat.

Our delineation of marginal murrelet landscapes includes more than 224,000 acres of DNR-managed lands located primarily in the Puget Trough lowlands from the Kitsap Peninsula south to the Columbia River (see Figure 6). These landscapes currently contain low amounts of murrelet habitat (about two percent) in small scattered patches, are located further than 5 km from any known occupied murrelet sites, and have a relatively low capacity for developing future habitat within the life of the HCP.

[6] The 5 km proximity distance is derived from research in southern Oregon and northern California that found that murrelets are less likely to occupy habitat if it is isolated (> 5 km) from other nesting murrelets (Meyer and others 2002).

Figure 6. Map of Marginal Landscapes for Murrelet Conservation



Calculating take and mitigation in marginal landscapes

In the marginal murrelet landscapes, we reduce all P-stage habitat values by 75 percent. In other words, P-stage habitat acres are given 25 percent of the P-stage habitat value for the purposes of calculating take and mitigation. In this way, we still account for potential take of murrelets associated with any habitat loss that may occur in these landscapes. We think the potential for take of murrelets in these areas is very low, but recognize that murrelet occupancy in these areas is not entirely discountable because they are located within the range of the species in Washington. Likewise, we apply mitigation credit for habitat conserved in areas of long-term forest cover, but at a reduced rate relative to other areas within the DNR lands that are more likely to contribute to long-term murrelet conservation.

Putting it all together: take and mitigation

Calculating the extent and intensity of potential impacts through the life of the HCP, and ensuring that a long-term conservation strategy minimizes and mitigates these impacts, is complex. The alternative long-term strategies being developed provide a range of approaches to how and where habitat is conserved. But this analytical framework ensures that the same metrics to calculate take and mitigation will be to evaluate every alternative in an environmental impact statement. That way, comparisons can be made among the alternatives to determine how well they work to minimize and mitigate impacts.

Attachment 1: Calculating the Mitigation for Disturbance

Example: Campground operations

Figure 1. Footprint, Buffer, and P-stage Habitat for One Campground, in Blue Shading; For Illustration Purposes Only

Potential stressors from the use and management of campgrounds are ground-based noise and visual disturbance. These can occur during the 176 day nesting season, every day of the week. The chart below walks through the calculations for determining the total acres impacted by this disturbance activity through the life of the HCP. The first step is using GIS to identify the potential acres of campground-disturbed habitat (Figure 1); DNR conducted this analysis for all its campgrounds in the analysis area. After the GIS analysis, a series of calculations are made to determine the number of impacted acres in LTFC that must be mitigated for this activity. The numbers provided are for illustration only.

Identify impacted habitat acres

Acres of P-stage habitat in campgrounds, plus 100m buffer	X Average P-stage value across DNR lands	= Acres impacted (weighted)
305	**.34**	**104**

Determine proportion of impacted acres in LTFC

104 acres	X .51 (51% of DNR lands in LTFC)	= **53 acres**

Adjust for time

Number of impacted acres	X Nesting season/ number of camp days	X Number of activity days out of a week	= Impacted acres during nesting season
53	**176/176**	**7/7**	**53**

Calculate over the life of the HCP

53 impacted campground acres during annual nesting season	X **52** years	= **2,756** time-adjusted acres of P-stage habitat disturbed by campground activities

Attachment 2: Roads as Edges

How do forest roads impact murrelet habitat?

Forest roads associated with timber harvests act as edges, which in turn affect the success of murrelet nests as discussed earlier in this paper. There is little information about the specific intensity of the edge effect that forest roads alone have on marbled murrelet nests. Some studies using artificial nests near logging roads did not show an increased predation effect (Yahner and Mahan 1997; Otega and Caplan 2002), but these studies were not conducted for canopy-nesting birds in Pacific Northwest forests. In a study from British Columbia using artificial murrelet nests near clearcuts, roads and other forest edges indicated increased corvid abundance and potential predation near artificial edges (Burger and others 2004). Steller's jays in particular are found in greater abundance at edges created by roads and clearings (Masselink 2001; Burger and others 2004; Vigallon and Marzluff 2005). Roads constructed close to or within murrelet habitat are assumed to attract Steller's jays closer into the forest interior (Masselink 2001). As discussed above, predation impacts have been found to be greatest within 50 meters of a forest edge.

Forest roads initially act as hard edges, and soften over time as they transition back to forest. Many roads are not being actively used, but are a relic of a previous management activity. As roads transition back into forest over the course of several decades, they have corresponding changes in the intensity of their edge effects. There is no accurate method for determining exactly where and how many new forest roads may be needed to access timber harvest sites through 2067. For purposes of analyzing how roads impact the habitat, it is assumed that the current density of DNR forest roads will remain stable through the life of the HCP. In other words, roads will be abandoned and new roads built, but the overall density will remain unchanged.

How is the road edge effect calculated?

The analytical framework adjusts the value of habitat located within 50 meters of a forest road to reflect potential increases in predation effects. The reduction in habitat value assumed attributable to roads can then be added to the other edge effect factors discussed in this paper. The level of a road's impact, and therefore it's "share" of the edge effect, depends on where the road is located relative to habitat. For example, a road located within an outer, hard edge created by a timber harvest has a concomitant edge effect with that of the harvest area. The road brings no additional predation impacts. But a road bisecting an inner edge is assumed to contribute a portion of the predation edge effect (which for inner, hard edge forests is a 31% reduction in nest success; McShane and others 2004). DNR applied a road edge effect factor throughout the landscape as 15.5% (half of 31%) to reflect these variations.

This road edge effect only applies to a small portion of the analysis area. DNR conducted a spatial analysis to identify how much marbled murrelet habitat is located within 50 meters of active roads. Roads located more than 50 meters from an interior forest were not counted as an edge. Approximately 4.8% of habitat was estimated to be subject to a road edge effect. The number of acres of habitat in different edge conditions, adjusted by other edge factors, can be multiplied by 4.8%, and then multiplied by the road edge factor of 15.5% to determine the road edge effect across the analysis area.

Percent of habitat in interior, or inner-edge LTFC assumed to be within 50 m of a road (4.8%)	x	**Acres of habitat in each edge condition, adjusted by other edge factors (varies depending on the conservation alternative)**	x	**Road edge factor (15.5%)**	=	**Acres of habitat impacted by roads**

The acres of road edge-impacted habitat are added to the total acres that are impacted by harvest and other edge factors. This methodology assumes that as new roads are built, older roads are abandoned, and new habitat grows, keeping the road edge effect consistent through the end of the HCP. Overall, the portion of the overall impacts from harvest and edges that are attributable to road edges alone is very small. However, this factor is incorporated into the analytical framework and reflected in the formulas used to determine how much mitigation is needed to offset potential impacts from forest management.

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Appendix I. 2007 and 2009 Concurrence Letters

Note: These letters outline processes to be implemented under the interim strategy to identify marbled murrelet habitat in the North Puget and South Puget HCP planning units.

WASHINGTON STATE DEPARTMENT OF
Natural Resources

PETER GOLDMARK
Washington State Commissioner of Public Lands

July 16, 2009

Mr. Ken Berg, Manager
Washington Fish and Wildlife Office
U.S. Fish and Wildlife Service
510 Desmond Drive SE, Suite 102
Lacey, WA 98503-1273

Mr. Berg,

I am writing in reference to the WA Department of Natural Resources (DNR) 1997 Habitat Conservation Plan (HCP) for state trust lands relative to marbled murrelet conservation in the HCP South Puget Planning Unit (SPPU). Mark Ostwald, from your office, Peter Harrison, DNR Wildlife Biologist, Alan Mainwaring, South Puget Sound Region Biologist, and I have been participating in the development of an alternate interim marbled murrelet conservation strategy (ICS) for the SPPU. This letter is intended to provide specific guidance for the successful implementation of Step 2 of the HCP interim marbled murrelet conservation strategy using alternative methodology in lieu of the habitat relationship study as the ICS describes.

Background

The 145,000 acre SPPU is located in the Puget Sound Basin and was subjected to harvest early in Euro-American settlement in the late 1800's and extensive rail logging in the early 1900's. Typically, stands were clear cut, burned and allowed to naturally regenerate. Today, suitable marbled murrelet habitat occurs in areas with scattered remnant old-growth, older western hemlock stands infected with dwarf mistletoe, and areas of steep inaccessible terrain with pre-settlement forest conditions. Suitable murrelet habitat comprises less than one percent of the DNR managed forest land in SPPU.

The SPPU is unique within the DNR's HCP planning units, in that although it is within the breeding range of marbled murrelets, the adjacent offshore population of murrelets is extremely low. It is estimated that there are less than 200 birds located offshore during the breeding season. Low population numbers and limited suitable habitat indicate that the probability of inland detections of murrelets is very low. This suspicion is corroborated by the fact that murrelet detections on non-DNR lands, adjacent to the SPPU, have also been low. Without an adequate number of inland detections, the habitat relationship study outlined in the HCP is ineffective. This has been shown to be true for the North Puget Planning Unit (NPPU), where low numbers of detections during the habitat relationship study resulted in an ineffective habitat model. In lieu of the habitat relationship study, the DNR has developed alternate methodologies that we believe effectively identifies potential murrelet habitat in the SPPU. This alternate methodology applies known features of murrelet habitat to existing forest inventory data to develop models and screening tools that identify areas of potential murrelet habitat. This alternate methodology also incorporates local and historical knowledge of known habitat areas. A similar process has been approved and applied in the NPPU with great success.

The purpose of this alternate approach to identify suitable marbled murrelet habitat is to adapt the current ICS to the unique circumstances in the SPPU while still meeting the overall intent of the HCP for murrelet conservation. It will also maintain conservation options for the forthcoming long-term conservation strategy, while keeping within the guidelines of the Incidental Take Permit issued to the DNR by your agency. We believe the following approach satisfies these objectives.

With the alternate interim marbled murrelet strategy outlined below, this document will supersede and replace the current interim marbled murrelet strategy for the SPPU (DNR HCP, IV pg. 39-46). The process described in this letter is intended for the interim period prior to the development of the long-term marbled murrelet conservation strategy for the SPPU. It is important to note this guidance follows the intent of the ICS five-step approach to implement the interim conservation strategy for the marbled murrelet. Implementation steps are detailed below.

1. Identification of Potential Suitable Marbled Murrelet Habitat
The following sources were used to identify "Potential Suitable Habitat":

- DNR's Weighted Old Growth Habitat Index,
- FRIS Age Data,
- Low level aerial surveys (Burger 2004),
- Forest Practices Board Manual Inventory Model Method for identifying marbled murrelet habitat, and
- local knowledge and professional judgment

The above sources were used to identify "Potential Suitable Habitat". Suitable habitat contains at a minimum, an average of at least 2 platforms per acre, in greater than or equal to a five-acre patch, and within 50 miles of marine water (HCP chapter IV pages 40-42),. "Potential Suitable Habitat" has not been field verified to determine whether it qualifies as suitable habitat.

A. <u>Definitions of Source Data to Identify "Potential Suitable Habitat"</u>

1. *Weighted Old Growth Habitat Index*1 *(WOGHI)*
The WOGHI is a scientifically derived screening tool developed and used by DNR to assess potential old growth. This indexing approach to old growth assessment is based on stand-level structural variables identified below and derived from the Forest Resource Inventory System (FRIS) data. This Geographic Information System (GIS) based tool has helped direct remote sensing review toward areas with large trees and structural complexity associated with murrelet nesting habitat. Variables of the WOGI include:
-Large trees (number of trees per acre > 40 inches dbh).
-Large snags (number of standing dead trees per acre > 20 inches dbh and >16 feet tall).
-Volume of down woody debris (cubic feet per acre).
-Tree size diversity – which is an indicator of multiple canopy structure

1 Franklin, J. F., T. Spies, R. Van Pelt, T. Riepe, S. Hull, and W. Obermeyer. 2005. Definition and inventory of old-growth forests on DNR-managed state lands. Washington State Department of Natural Resources, Olympia, Washington.

2. *FRIS Age Data*
Stands recorded as 100 years or older were reviewed with digital orthophotos or aerial photos for canopy structure indicative of older forest.

3. *Forest Practices Board Manual for Marbled Murrelet Inventory Model Method*
This sampling method utilized the Board Manuals Inventory Model Method-WAC 222-12-090(15) (b). Using DNR's FRIS data DNR queried for stands likely to contain murrelet habitat characteristics utilizing the manuals Platform Units per Tree table which were incorporated into a GIS tool.

4. *Low-Level Aerial Surveys*
Remote areas of the SPPU and NPPU were evaluated for habitat quality utilizing Alan Burger's *Standard Methods for Identifying and Ranking Nesting Habitat of Marbled Murrelets in British Columbia* (Burger 2004) using Air Photo Interpretation and Low-Level Aerial Surveys.

5. *Local Knowledge and Professional Judgment*
Experienced state lands foresters and wildlife biologists examined landscape maps and delineated known and potential murrelet habitat based their expert opinion and their local knowledge of the sites. All proposed management activities are also evaluated for the presence of "Potential Suitable Habitat" prior to management activities taking place.

B. Existing Data
To date, approximately 7,853 acres of potential marbled murrelet habitat have been identified in the SPPU. DNR and USFWS biologists have agreed the habitat definition is likely to capture a sufficient proportion of the potential marbled murrelet habitat to advance the interim and long-term conservation strategies.

Over the last several years DNR Biologists and private contractors have field assessed 5,722 acres of the potential habitat (7,853 acres). The remaining 2,131 acres of potential habitat will be field assessed for habitat suitability as time and budget permits. Identified potential habitat will be treated as occupied to include buffers and timing restrictions while in the interim conservation strategy or until field assessments are completed and a habitat determination is made. The table below summarizes the planning unit habitat status to date.

Table 1. Habitat Status by Area and Acreage (see attached maps for SPPU Tiger, Elbe, Black Diamond, and Belfair)

Area	Suitable Habitat	Unsuitable Habitat	Occupied Habitat	Potential Habitat
Tiger Mt.	142	559	0	0
Elbe/Tahoma	96	816	468	1,377
Black Diamond	355	2,524	111	0
Belfair/Kitsap	81	570	0	754
Totals:	674	4,469	579	2,131
Total acres of habitat identified in SPPU				**7,853**

C. <u>Newly Identified Suitable Habitat</u>
Hereafter, any newly identified suitable habitat blocks of 5 acres or more containing an average of 2 platforms per acre and within 50 miles of marine waters will not be required to be surveyed, but will be deferred from harvest during the ICS. The term "newly identified suitable habitat" is defined as, potential habitat that was not found during the original selection process for potential marbled murrelet habitat. It is expected that the long-term marbled murrelet conservation strategy will make determinations regarding how these newly identified suitable habitat areas may contribute to murrelet conservation. Any newly identified suitable habitat blocks of 5 acres or more will have a forested buffer applied to the habitat patch and a timing restriction applied. DNR will maintain a record of newly identified suitable habitat and report the acreage to the Services annually.

A habitat condition that will require special attention in newly-identified suitable habitat blocks is described as relatively young western hemlock stands in which incipient, mistletoe-induced witch's brooms comprise essentially the only platform structures in the stand; this is in distinction to older stands with mixed species and an array of platform types, including well-developed mistletoe brooming. USFWS, DNR and WDFW staff biologists met to review this issue and agreed to work directly with WDFW staff when field assessing this habitat condition.

2. Field Verification of Potential Marbled Murrelet Habitat Suitability
DNR staff biologists, trained foresters, or trained contractors will review each potential marbled murrelet habitat polygon in the field to verify and map the extent of suitable habitat.

Contiguous areas of suitable habitat extending outside the original (potential marbled murrelet habitat) polygon will be incorporated in the suitable habitat delineation. "Potential Habitat" not meeting the suitable habitat definition as defined above, will be classified as "unsuitable habitat". Following this field assessment, each potential habitat polygon will be fully resolved into suitable or unsuitable habitat areas. DNR's GIS marbled murrelet habitat layer will be maintained to reflect this field-based habitat status determination.

3. Release of Unsuitable Marbled Murrelet Habitat
Areas that have been field-verified and identified as unsuitable habitat will be candidates for immediate release within the framework of the HCP. The Ecosystem Services Section of the DNR Land Management Division will be notified before unsuitable habitat is released. This release process requires documentation, both in writing and identified on maps. Once the proper documentation has been received by the Ecosystem Services Section, the unsuitable habitat is officially released for the full range of management activities. Released acreages of unsuitable habitat will also be documented in the HCP Annual Report to the Services. Areas that meet the definition of suitable habitat will not be released at this time, regardless of occupancy status.

4. Protection of Suitable Marbled Murrelet Habitat
All suitable marbled murrelet habitat (field delineated) will be protected with a 300-foot managed buffer (as per WAC 222-16-080 (1) (j) (v)) or a 165-foot no touch buffer. Lesser buffers may be sufficient in certain topographic situations (i.e., buffers generally need not extend over a ridge top onto the opposite slope).

5. Protection of Occupied Sites
All occupied sites will be protected until the long-term conservation strategy for the SPPU is completed. Occupied sites will be protected by a 300-foot managed buffer, or a 165-foot no touch buffer. Timing restrictions will also be applied.

Summary
Throughout the interim strategy outlined above, the Land Management Division's Ecosystem Services Section will be responsible to maintain and update the corporate marbled murrelet habitat GIS layers to reflect the current status of all habitat areas.

If new information on marbled murrelet ecology becomes available relevant to the SPPU, and it conflicts with the intent of the HCP conservation goals, this letter will be modified or replaced. At no time will the HCP conservation goals described for marbled murrelets be compromised. It is DNR's opinion that the approaches described in this document meet the intention of the HCP and USFWS decision documents. Any future information that contradicts this will be closely analyzed by the DNR and USFWS to determine alternative approaches.

Please signify your concurrence with the approach outlined above by signing each of these two originals. Please return one original to me and retain the other original for your records. It is always a pleasure to work with you and your staff.

Sincerely,

Tami Mikita

Tami Miketa
Assistant Division Manager
Ecosystem Services Section
Land Management Division
WA Dept. of Natural Resources

I concur with the approaches outlined above:

James L Michaels — Date: 7/17/09

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

Attachment: Accompanying maps showing areas of potential, suitable, and unsuitable habitat. Known occupied areas are also identified.

cc: Gretchen Nicholas, Land Management Division Manager
Jed Herman, Product Sales and Leasing Division Manager
Randy Acker, South Puget Sound Region Manager

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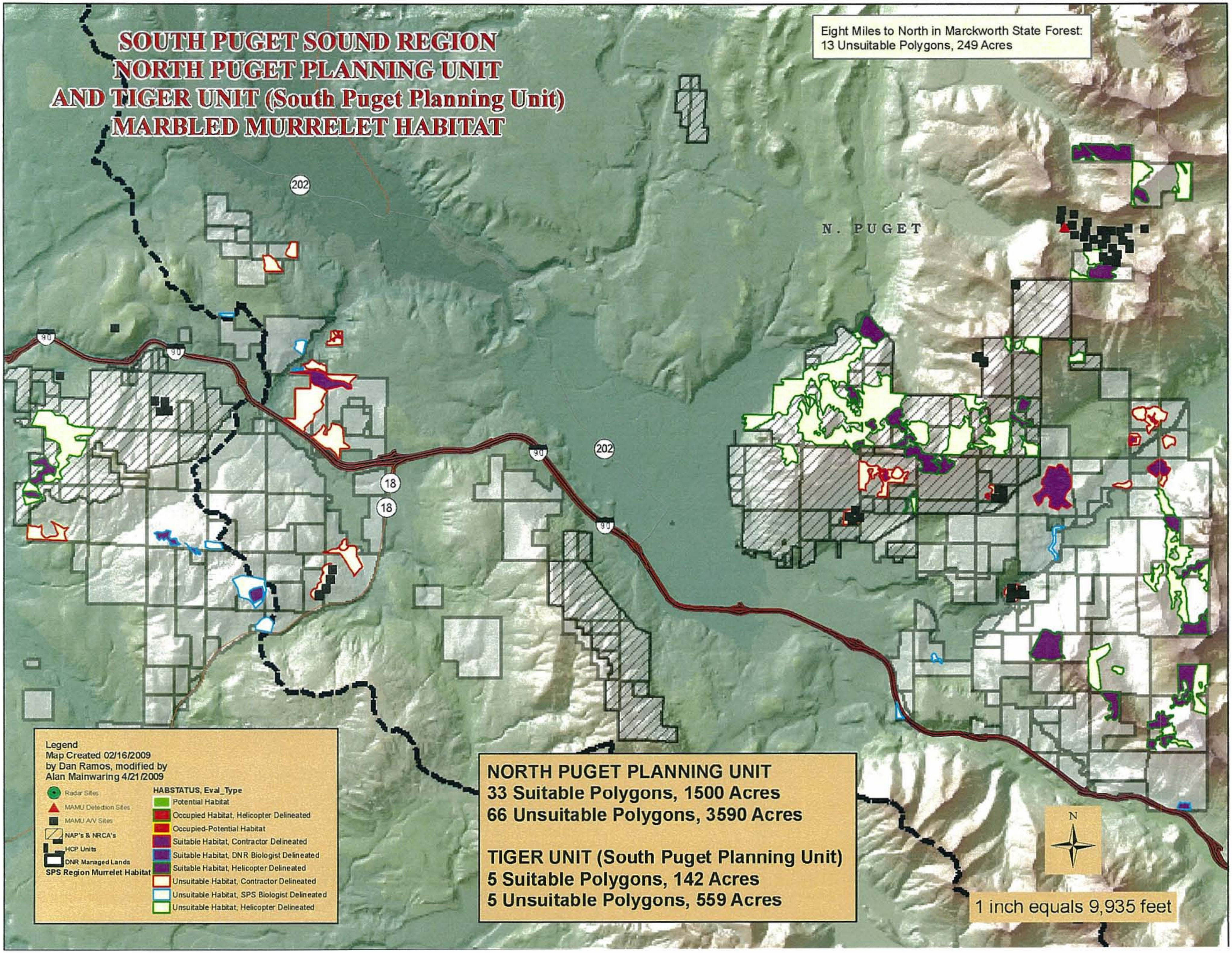
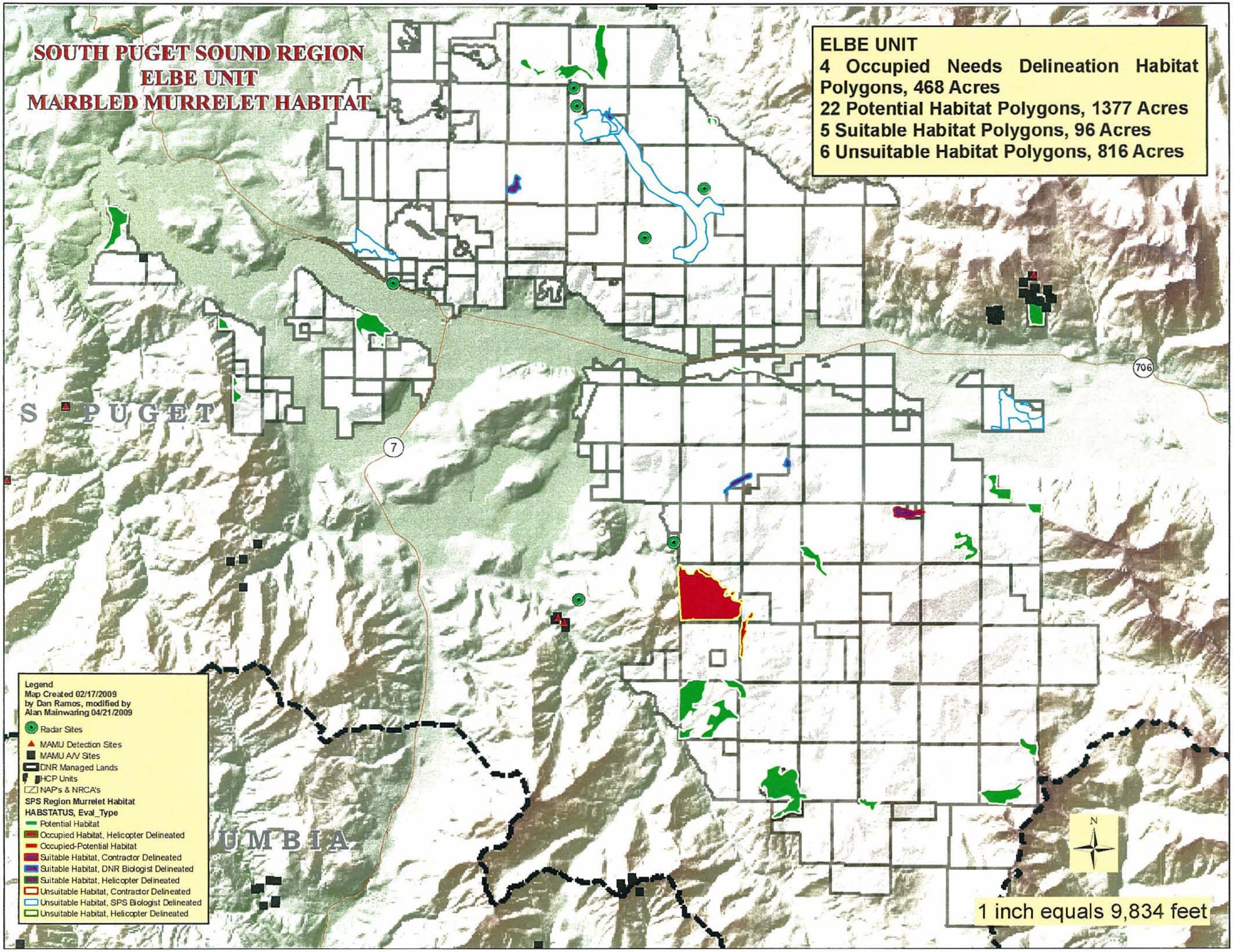


SOUTH PUGET SOUND REGION
NORTH PUGET PLANNING UNIT
AND TIGER UNIT (South Puget Planning Unit)
MARBLED MURRELET HABITAT
Eight Miles to North in Marckworth State Forest:
13 Unsuitable Polygons, 249 Acres
N. PUGET
202
90
18
Legend
Map Created 02/16/2009
by Dan Ramos, modified by
Alan Mainwaring 4/21/2009
Radar Sites
MAMU Detection Sites
MAMU A/V Sites
NAP's & NRCA's
HCP Units
DNR Managed Lands
SPS Region Murrelet Habitat
HABSTATUS, Eval_Type
Potential Habitat
Occupied Habitat, Helicopter Delineated
Occupied-Potential Habitat
Suitable Habitat, Contractor Delineated
Suitable Habitat, DNR Biologist Delineated
Suitable Habitat, Helicopter Delineated
Unsuitable Habitat, Contractor Delineated
Unsuitable Habitat, SPS Biologist Delineated
Unsuitable Habitat, Helicopter Delineated
NORTH PUGET PLANNING UNIT
33 Suitable Polygons, 1500 Acres
66 Unsuitable Polygons, 3590 Acres
TIGER UNIT (South Puget Planning Unit)
5 Suitable Polygons, 142 Acres
5 Unsuitable Polygons, 559 Acres
N
1 inch equals 9,935 feet


SOUTH PUGET SOUND REGION
ELBE UNIT
MARBLED MURRELET HABITAT
ELBE UNIT
4 Occupied Needs Delineation Habitat Polygons, 468 Acres
22 Potential Habitat Polygons, 1377 Acres
5 Suitable Habitat Polygons, 96 Acres
6 Unsuitable Habitat Polygons, 816 Acres
S PUGET
UMBIA
7
706
Legend
Map Created 02/17/2009
by Dan Ramos, modified by
Alan Mainwaring 04/21/2009
Radar Sites
MAMU Detection Sites
MAMU A/V Sites
DNR Managed Lands
HCP Units
NAP's & NRCA's
SPS Region Murrelet Habitat
HABSTATUS, Eval_Type
Potential Habitat
Occupied Habitat, Helicopter Delineated
Occupied-Potential Habitat
Suitable Habitat, Contractor Delineated
Suitable Habitat, DNR Biologist Delineated
Suitable Habitat, Helicopter Delineated
Unsuitable Habitat, Contractor Delineated
Unsuitable Habitat, SPS Biologist Delineated
Unsuitable Habitat, Helicopter Delineated
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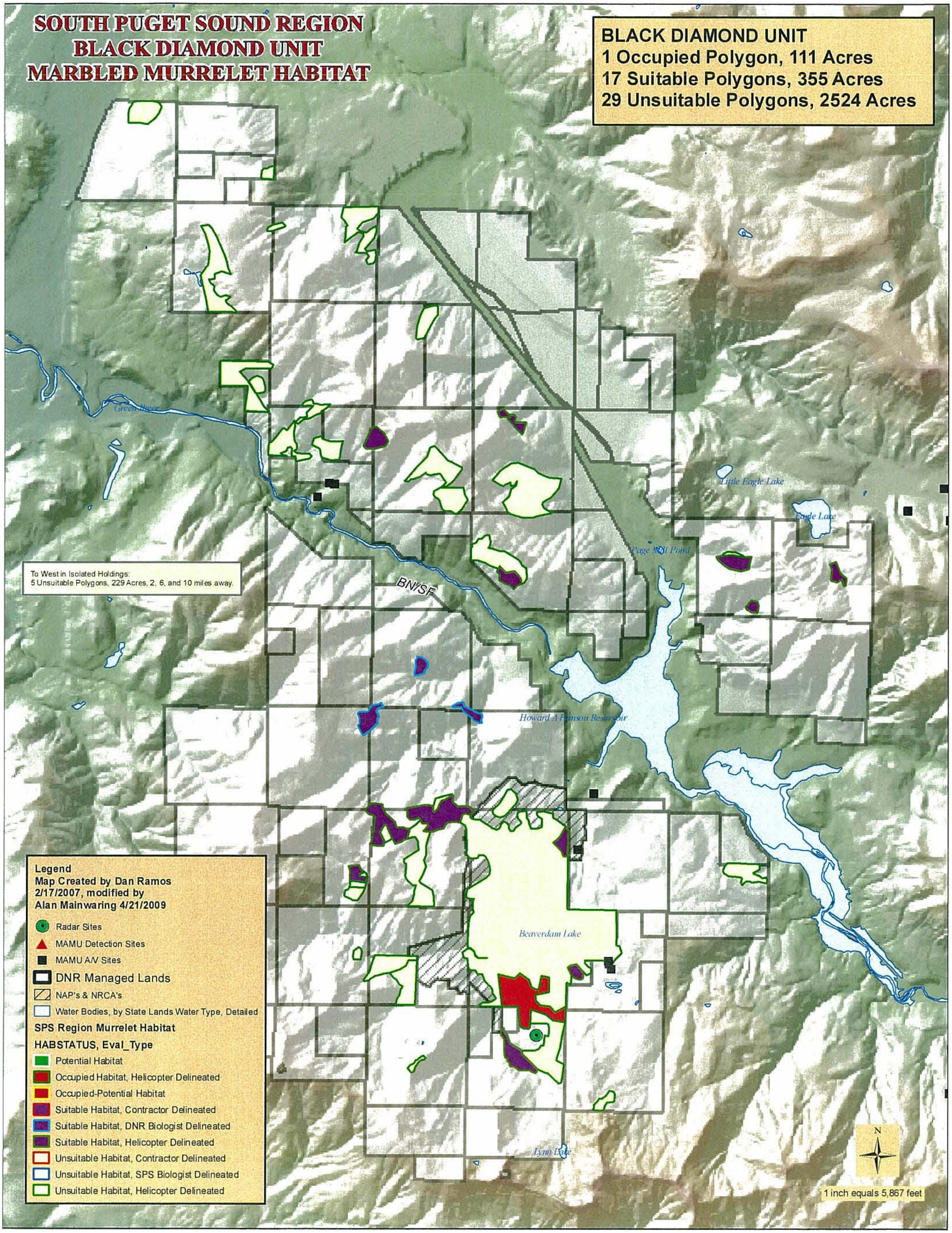
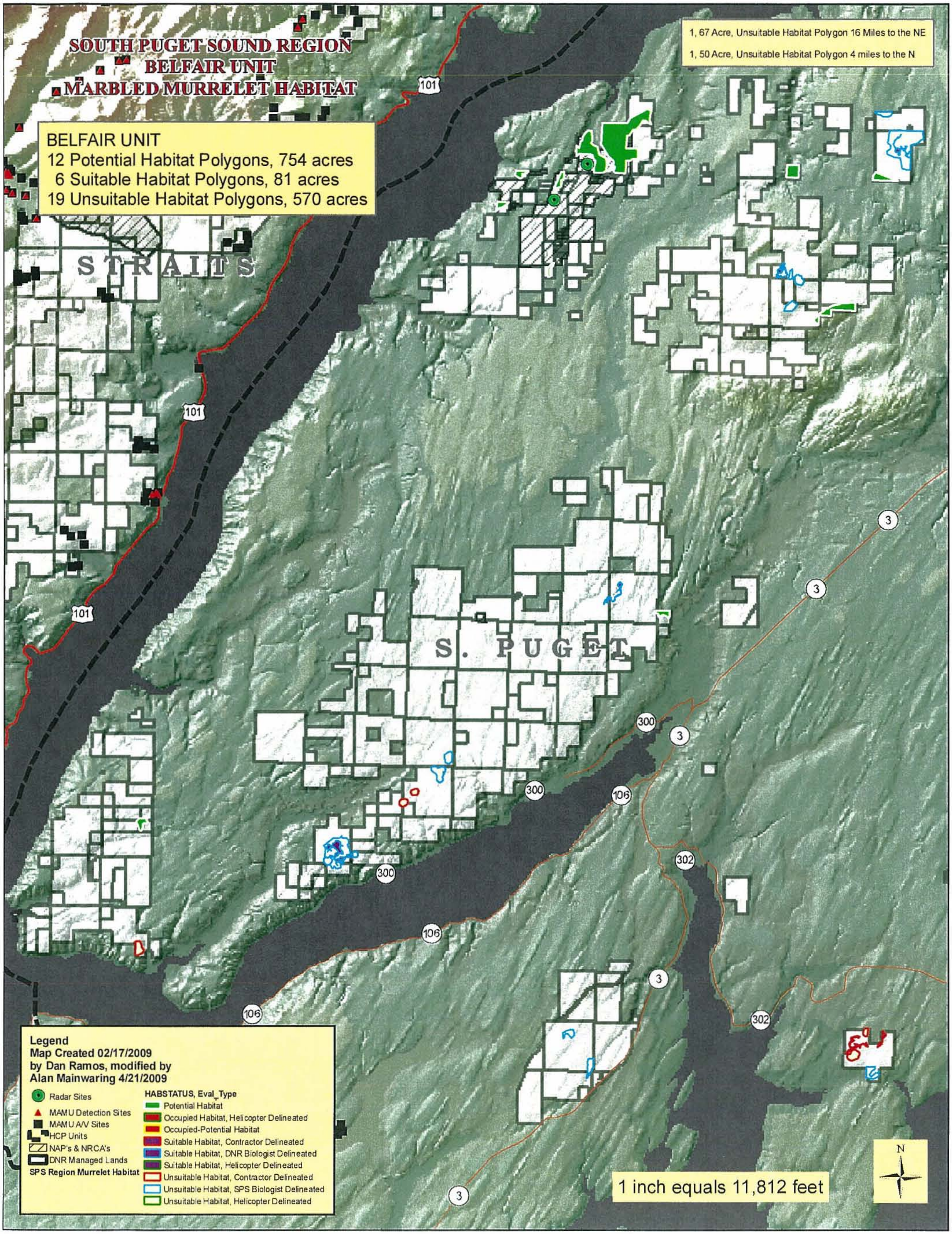
1 inch equals 9,834 feet



SOUTH PUGET SOUND REGION
BLACK DIAMOND UNIT
MARBLED MURRELET HABITAT
BLACK DIAMOND UNIT
1 Occupied Polygon, 111 Acres
17 Suitable Polygons, 355 Acres
29 Unsuitable Polygons, 2524 Acres
Green River
To West in Isolated Holdings:
5 Unsuitable Polygons, 229 Acres, 2, 6, and 10 miles away.
BNSF
Little Eagle Lake
Eagle Lake
Page Mill Pond
Howard A Hanson Reservoir
Beaverdam Lake
Lynn Lake
Legend
Map Created by Dan Ramos
2/17/2007, modified by
Alan Mainwaring 4/21/2009
Radar Sites
MAMU Detection Sites
MAMU A/V Sites
DNR Managed Lands
NAP's & NRCA's
Water Bodies, by State Lands Water Type, Detailed
SPS Region Murrelet Habitat
HABSTATUS, Eval_Type
Potential Habitat
Occupied Habitat, Helicopter Delineated
Occupied-Potential Habitat
Suitable Habitat, Contractor Delineated
Suitable Habitat, DNR Biologist Delineated
Suitable Habitat, Helicopter Delineated
Unsuitable Habitat, Contractor Delineated
Unsuitable Habitat, SPS Biologist Delineated
Unsuitable Habitat, Helicopter Delineated
N
1 inch equals 5,867 feet



SOUTH PUGET SOUND REGION
BELFAIR UNIT
MARBLED MURRELET HABITAT
BELFAIR UNIT
12 Potential Habitat Polygons, 754 acres
6 Suitable Habitat Polygons, 81 acres
19 Unsuitable Habitat Polygons, 570 acres
1, 67 Acre, Unsuitable Habitat Polygon 16 Miles to the NE
1, 50 Acre, Unsuitable Habitat Polygon 4 miles to the N
STRAITS
S. PUGET
101
3
300
106
302
Legend
Map Created 02/17/2009
by Dan Ramos, modified by
Alan Mainwaring 4/21/2009
Radar Sites
MAMU Detection Sites
MAMU A/V Sites
HCP Units
NAP's & NRCA's
DNR Managed Lands
SPS Region Murrelet Habitat
HABSTATUS, Eval_Type
Potential Habitat
Occupied Habitat, Helicopter Delineated
Occupied-Potential Habitat
Suitable Habitat, Contractor Delineated
Suitable Habitat, DNR Biologist Delineated
Suitable Habitat, Helicopter Delineated
Unsuitable Habitat, Contractor Delineated
Unsuitable Habitat, SPS Biologist Delineated
Unsuitable Habitat, Helicopter Delineated
1 inch equals 11,812 feet
N

WASHINGTON STATE DEPARTMENT OF
Natural Resources

DOUG SUTHERLAND
Commissioner of Public Lands

February 23, 2007

Mr. Ken Berg
U.S. Fish and Wildlife Service
510 Desmond Drive SE, Suite 102
Lacey, WA 98503-1273

Dear Mr. Berg:

I am writing in reference to our 1997 Washington Department of Natural Resources (DNR) Habitat Conservation Plan (HCP) for state trust lands relative to marbled murrelet conservation in the North Puget Planning Unit (NPPU). Mark Ostwald from your office, staff from the Washington Department of Fish and Wildlife (WDFW), Peter Harrison, DNR Biologist, and I have been participating in development of the interim marbled murrelet conservation strategy for the NPPU. This letter is intended to provide specific guidance for the successful implementation of the interim strategy and replace the former interim approach described in the November 18, 2002, letter to the United States Fish and Wildlife Service (USFWS) from the DNR HCP Implementation Manager.

A unique set of circumstances became apparent during the first two years of marbled murrelet inventory surveys in the NPPU. Areas of significantly higher quality marbled murrelet habitat were discovered scattered throughout areas in the planning unit. However, these pockets of higher quality marbled murrelet habitat were not identified by the predictive habitat model, and thus were not scheduled to be surveyed for marbled murrelet occupancy which put those areas at risk of harvest. This issue began a series of discussions between WDFW, USFWS, and DNR staff on how to resolve the issue. The first resolution was identified in the November 18, 2002 letter referenced above. This resolution is outlined in points 1 & 2 below:

1. A re-examination of the habitat predictive model that identified forested stands that should be selected for marbled murrelet inventory surveys (N=28,000 acres) resulted in an additional model run that identified approximately 6,000 acres of additional marbled murrelet habitat to be inventoried. This step significantly improved the habitat selection process for NPPU.

2. Beyond the model-identified habitat areas, the continuing occurrence of small areas ($\geq$ 5 acres in size) containing residual large diameter conifer trees, isolated scattered dominant conifer trees, and hemlock stands with mistletoe nest platforms was also addressed. It was agreed to protect the first two of these habitat conditions in order to retain these structures for potential contribution to long-term marbled murrelet conservation. This step added additional protections to murrelet habitat because these types of habitat were not protected under the original interim conservation strategy for the marbled murrelet in the NPPU.

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Since 2002, DNR has been gaining more knowledge about murrelet occupancy patterns on state managed lands and how it integrates with other DNR management activities. As such, we are proposing to modify the current interim marbled murrelet approach with the approach described in this letter. It is our opinion that this new interim approach satisfies the objectives of the HCP and complies with the parameters of the Incidental Take Permit issued by your agency. These steps, and the process outlined in this letter, will result in significant improvements to the interim marbled murrelet conservation strategy for the NPPU by capturing areas containing pockets of higher quality marbled murrelet habitat and conducting a protocol inventory survey in order to determine occupancy rates. These steps will allow DNR to develop a more informed long-term strategy for marbled murrelets in the NPPU, and to successfully fulfill the overall commitments in the HCP for marbled murrelet conservation.

Our revised interim strategy is described below. We propose that this document replace the interim approach described in the November 18, 2002, letter. Similar to this previous document, the process described in this letter is intended only for the interim period prior to the development of the long-term marbled murrelet conservation strategy for the NPPU.

1. Identification of Potential Suitable Marbled Murrelet Habitat
All areas identified by the various sources (predictive modeling efforts, local knowledge, and professional judgment) are mapped as "**potential habitat**". These are areas *expected* to meet the HCP definition of suitable marbled murrelet habitat (containing an average of 2 platforms per acre, ≥ five-acre patches, and within 50 miles of marine water; HCP chapter IV pages 40-42), but which have not been verified in the field to determine suitability.

Potential marbled murrelet habitat includes:

a. All areas captured in the predictive model (Reclassified and Reclassified Plus).

b. Other potential habitat identified by DNR foresters and biologists, as well as representatives from WDFW, USFWS and local Tribes. These areas are identified from field knowledge and other sources.

The original source of each polygon of potential habitat (modeled, field knowledge, or other) will be retained in a GIS marbled murrelet habitat database.

To date, approximately 40,224 acres (see map) of potential marbled murrelet habitat have been identified in the Northwest Region of the NPPU. Identification of potential marbled murrelet habitat for the South Puget Sound Region portion of the NPPU has been initiated. DNR, WDFW, and USFWS biologists have agreed that this process is likely to capture a sufficient proportion of the potential marbled murrelet habitat to advance the interim and long-term marbled murrelet conservation strategies for this planning unit.

Although DNR attempted to locate all potential habitat in the NPPU, there may be potential habitat in this planning unit not previously identified. The term "**newly identified suitable habitat**" is defined as habitat that was not located during the original selection process for potential marbled murrelet habitat. Hereafter, any newly identified suitable habitat blocks of 5 acres or more will not be surveyed for murrelet occupancy, but will be deferred from harvest during this interim period. During this interim period any newly identified suitable habitat blocks of 5 acres or more will not be required to have a buffer adjoining the habitat patch or a harvest timing restriction in adjacent unsuitable habitat.[1] The contribution of these unsurveyed newly identified suitable habitat blocks to the conservation strategy will be considered in the long-term marbled murrelet conservation planning process.

It is our opinion that the lack of a buffer and timing restriction for certain newly identified suitable habitat is a low risk element of this interim process due to the frequency of this type of unidentified suitable habitat occurring on the landscape. Additionally, if this does occur, it is our belief that it will most likely be low quality habitat – with a low chance of occupancy. If new information becomes available regarding occupied sites in the NPPU, the adaptive management process will be used to inform any further guidance on this issue.

One habitat type that will require special attention in newly-identified suitable habitat blocks is described as relatively young hemlock stands in which incipient, mistletoe-induced witches brooms comprise essentially the only platform structures in the stand; this is in distinction to older stands with mixed species and an array of platform types, including well-developed mistletoe brooming. USFWS, DNR, and WDFW staff biologists met to review this issue and agreed to work directly with WDFW staff when evaluating this habitat type.

2. ***Field Verification of Potential Marbled Murrelet Habitat Suitability***
DNR staff biologists, foresters, or trained contractors will review each potential marbled murrelet habitat polygon in the field to verify and map the extent of **suitable marbled murrelet habitat**.

Contiguous areas of suitable habitat extending outside the original (potential marbled murrelet habitat) polygon will be incorporated in the suitable habitat delineation. Any area without contiguous suitable habitat as defined above will be classified as "**unsuitable habitat**". Following this field evaluation, each potential habitat polygon will be fully resolved into suitable or unsuitable habitat areas. DNR's GIS marbled murrelet habitat layer will be maintained to reflect this field-based habitat status determination.

3. ***Release of Unsuitable Marbled Murrelet Habitat***
Areas that have been field-verified and identified as unsuitable habitat will be candidates for immediate release within the framework of the HCP.

---

[1] See one exception to this requirement in this document under "Timing Restrictions Required".

a. The HCP/Science Section of the DNR Land Management Division will be notified before unsuitable habitat is released; the HCP/Science Section will then notify USFWS staff in a timely manner. This release process requires documentation, both written and mapped, that will be sent to both NW Region and Region WDFW Biologists and the HCP/Science Section. Once the proper documentation has been received by the HCP/Science Section, the unsuitable habitat is officially released for the full range of management activities. Release acreages will be documented in the HCP Annual Report to the Services.

b. Some previously surveyed and unoccupied modeled habitat polygons may contain unsuitable habitat. These polygons will also be released (following the process outlined above) if field assessments deem appropriate. For surveyed polygons that contain a mixture of suitable and unsuitable habitat, with no occupancy, the suitable habitat will be deferred from harvest, while the unsuitable habitat will be released for the full range of management activities.

4. ***Protection and Survey of Suitable Marbled Murrelet Habitat***
All suitable marbled murrelet habitat will receive inland protocol surveys using methods approved by the Pacific Seabird Group or other methods approved by the USFWS, with the exception of suitable habitat in Natural Resource Conservation Areas and Natural Area Preserves. In these areas the DNR will survey a sample of the suitable habitat. Appropriate sampling design will be developed mutually between the DNR and the USFWS. It is likely that sampling will occur at a rate between 20-50%.

a. All suitable marbled murrelet habitat (field delineated) will be protected with a 300-foot managed buffer (as per WAC 222-16-080 (1)(j)(v)) or a 165-foot no touch buffer until surveys are completed. Lesser buffers may be sufficient in certain topographic situations (i.e., buffers generally need not extend over a ridge top onto opposite slope). Timing restrictions will not be applied to management activities. These buffers are to be applied to the suitable habitat areas delineated from the currently identified and mapped potential habitat (40,224 acres) and immediately adjacent to proposed fiscal year 2008 sales and beyond.

b. Buffers will not be required for unsurveyed suitable habitat immediately adjacent to any timber sales sold fiscal year 2007 and earlier.

c. Once surveys are complete, buffers and timing restrictions are not required for unoccupied, suitable marbled murrelet habitat areas.

5. ***Protection of Occupied Sites***
All occupied sites will be protected until the long-term conservation strategy for the NPPU is finalized. Occupied site boundaries will be determined on a case-by-case basis and in

collaboration with USFWS and WDFW staff. Occupied sites will be protected by a 300-foot managed buffer, or a 165-foot no touch buffer (as above). Timing restrictions will also be applied to occupied sites.

6. *Management of Suitable Marbled Murrelet Habitat per WAU*

As per Step. 4 of the HCP Interim Marbled Murrelet Conservation Strategy (HCP Chapter IV p.40), some unoccupied suitable marbled murrelet habitat will be released for harvest. This follows successful completion of surveys in all suitable habitat below 3000' elevation in the north half of the NPPU (defined as the WAU division between the North Stillaguamish and South Stillaguamish WAU's, see attached map). DNR and the USFWS will consider further release of unoccupied suitable marbled murrelet habitat in the south half of the NPPU once those surveys are complete.

Surveyed unoccupied marbled murrelet habitat will be released for harvest if it is not within 0.5 miles of an occupied site and, after harvest, at least 50% of the suitable habitat on DNR-managed lands in the WAU would remain. This release process will require collaboration and concurrence by the USFWS prior to scheduling any management activities.

7. Allowable Operational Access in the Form of Roads and/or Yarding Corridors in Newly Identified Suitable Marbled Murrelet Habitat.

The DNR has a timber sale program consistent with the HCP in the NPPU. It has a high dependency on road access for timber harvest operations. Infrequently, these roads may conflict with newly identified suitable habitat. For the purpose of the interim time frame, operational access in the form of roads and/or yarding corridors will be allowed in **newly identified** suitable marbled murrelet habitat that meets the following criteria. This allowance for management in lower quality habitat types follows the guidelines in Step 2 of the HCP's marbled murrelet interim strategy (HCP IV.40). Data to develop these criteria were derived from current marbled murrelet occupied sites found within the North Puget Planning Unit.

Criteria 1

- Habitat ≥ 5 acres but ≤ 10 acres with ≤ 10 platforms per acre **OR**
- Habitat >10 acres but ≤ 20 acres with ≤ 5 platforms per acre

As described under Criteria 1, if all or part of a suitable habitat block is within 0.25 miles of an occupied site, a two year protocol survey of the stand must be completed. If the stand is found to be unoccupied, operational access will be acceptable.

Criteria 2

- After a two year marbled murrelet protocol survey the stand is found to be unoccupied **AND**
- Habitat ≥ 5 acres but ≤ 10 acres with >10 platforms per acre **OR**

- Habitat > 10 acres but ≤ 20 acres with > 5 platforms per acre **OR**
- Habitat > 20 acres with ≤ 15 platforms per acre

Harvesting of Platform Trees

In all cases under Criteria 1 & 2, loss of platform trees **will** be minimal while allowing access needs. Where loss of platform trees is operationally unavoidable, highest priority must be given to retention of multi-platform trees (trees with ≥ 4 platforms). USFWS and WDFW will be consulted to ensure that the loss or damage to platform trees is minimal.

Timing Restrictions Required

When operating within newly identified suitable habitat, yarding or operation of heavy machinery, felling or bucking **will not** be allowed during the daily peak activity periods within the critical nesting season. The critical nesting season is April 1st through August 31st. The daily peak activity period is defined as one hour before official sunrise to two hours after official sunrise and one hour before official sunset to one hour after official sunset.

No management will be allowed in newly-identified suitable habitat that meets the following criteria:

Criteria 3

- Habitat ≥ 20 acres with > 15 platforms per acre
- Where this high quality habitat condition occurs, buffers and timing restrictions will be applied to these stands during the interim strategy period.

Pre-Approval Required

As early as possible in the presale planning process, the Region will submit documentation that describes the need for operational access through newly identified suitable habitat as described in Criteria 1 and 2. Any request for access through Criteria 2 areas will have completed murrelet occupancy survey results available. Adequate documentation must identify why access through suitable habitat is justified. Submit requests to the Land Management Division, HCP/Science Section for review and written approval.

Throughout the interim strategy outlined above, the Land Management Division's HCP Implementation Data Steward will be responsible to maintain and update the corporate marbled murrelet habitat GIS layers to reflect the current status of all habitat areas.

Summary

This agreement is for the interim marbled murrelet conservation strategy for DNR's HCP in the NPPU and is not intended to preclude future options for the long-term conservation strategy. If there is new empirical data related to murrelet occupancy on DNR-managed lands in the NPPU indicating that the measures outlined above fall short of the HCP commitments, we agree to make the necessary modifications to ensure the HCP objectives are met.

It is our opinion that this interim approach is consistent with the HCP. We note that the application of buffers and timing restrictions in many situations, intensive field inspections to determine murrelet habitat suitability, close oversight of marbled murrelet occupancy surveys, collaboration with WDFW and others to locate potential murrelet habitat all contribute to making this an appropriate interim conservation strategy. We also believe this interim approach improves upon the memo dated November 18, 2002. With this interim strategy we believe that we are maintaining substantial opportunities for credible long-term conservation planning for marbled murrelets and are complying with our Incidental Take Permit.

Please signify your concurrence with this agreement by signing below.

Sincerely,

Tami Miketa

Tami Miketa, HCP/Science Section
Assistant Division Manager
Land Management Division
WA Dept. of Natural Resources

I concur with the approaches outlined above:

James L Michaels — Date: 3/9/07

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

cc: Gretchen Nicholas, Land Management Division Manager
Jed Herman, Product Sales and Leasing Division Manager

Appendix J. Fish Distribution in the Analysis Area

This appendix supports information presented in Section 3.4, Aquatic Resources.

Table M-1 Fish Species Spawning and Rearing by Region

Species/Population Name and Status	North Puget Sound	South Puget Sound	West Puget Sound	Olympic Coast	Southwest Washington
Endangered Species					
NA					
Threatened Species					
Puget Sound Chinook *(O. tshawytscha)*	X	X	X		
Hood Canal Summer Chum *(O. keta)*			X		
Ozette Lake Sockeye *(O. nerka)*				X	
Bull Trout Coastal-Puget Sound DPS *(Salvelinus confluentus)*	X	X	X	X	X
Unlisted Fish Species					
Pink Salmon (all ESUs***) *(O. gorbuscha)*	X	X	X	X	
Coho all ESUs) *(O. kisutch)*	X[2]	X[2]	X[2]	X[2]	X[2]
Chinook (all unlisted ESUs) *(O. tshawytscha)*	X	X	X	X	X
Chum (all unlisted ESUs) *(O. keta)*	X	X	X	X	X
Sockeye/Kokanee (all unlisted ESUs) *(O. nerka)*	X	X	X	X	X
Steelhead/Rainbow(all unlisted ESUs) *(O. mykiss)*	X	X	X	X	X

Species/Population Name and Status	North Puget Sound	South Puget Sound	West Puget Sound	Olympic Coast	Southwest Washington
Cutthroat Trout [1] *(O. clarki)*	X	X	X	X	X
Pacific Lamprey [1] *(Lampetra tridentata)*	X	X	X	X	X
River Lamprey[1,4] *(L. ayresi)*	X	X	X		
Western Brook Lamprey *(L. richardsoni)*	X	X	X	X	X
Pygmy Whitefish[3] *(Prosopium coulteri)*		X		X	
Mountain Whitefish *(P. williamsoni)*	X	X	X	X	X
Olympic Mudminnow [3] *(Novumbra hubbsi)*		X	X	X	X
Redside Shiner *(Richardsonius balteatus)*	X	X		X	X
Longnose Dace *(Rhinichthys cataractae)*	X	X		X	X
Speckled Dace *(R. osculus)*		X	X	X	X
Northern Pikeminnow *(Ptychocheilus oregonensis)*		X		X	X
Peamouth *(Mylocheilus caurinus)*	X	X	X	X	
Largescale Sucker *(Catostomus macrocheilus)*	X	X		X	X
Salish Sucker [5] *(C. carli* – species pending*)*	X	X	X		
Three-Spine Stickleback *(Gasteroseius aculeatus)*	X	X	X	X	X
Coastrange Sculpin *(Cottus aleuticus)*	X	X	X	X	X
Prickly Sculpin *(C. asper)*	X	X	X	X	
Reticulate Sculpin *(C. perplexus)*		X	X	X	X
Riffle Sculpin *(C. gulosus)*		X	X	X	X

Species/Population Name and Status	North Puget Sound	South Puget Sound	West Puget Sound	Olympic Coast	Southwest Washington
Shorthead Sculpin *(C. confuses)*	X	X	X	X	
Torrent Sculpin *(C. rhotheus)*	X	X	X	X	X
Longfin Smelt *(Spirinchus thaleichthys)*	X	X			
White Sturgeon *(Acipenser transmontanus)*		X			X

[1]Federal Species of Concern

[2]Federal Candidate Species

[3] State Sensitive Species: "Any wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened throughout a significant portion of its range within the state without cooperative management or removal of threats."

(WAC 232-12-297, Section 2.6)

[4] State Candidate Species: "Include fish and wildlife species that the Department will review for possible listing as State Endangered, Threatened, or Sensitive. A species will be considered for designation as a State Candidate if sufficient evidence suggests that its status may meet the listing criteria defined for State Endangered, Threatened, or Sensitive." *(WDFW Policy M-6001)*

[5] State Monitor Species: State Monitor species are not considered Species of Concern, but are monitored for status and distribution. These species are managed by the Department, as needed, to prevent them from becoming endangered, threatened, or sensitive.

Appendix K. Rare Plants in LTFC

HCP Planning Unit	Type	Scientific name	Common Name
COLUMBIA	**VASCULAR**	Erigeron aliceae	Alice's fleabane
		Euonymus occidentalis var. occidentalis	western wahoo
		Filipendula occidentalis	queen of the forest
		Packera bolanderi var. harfordii	Harford's ragwort
		Poa laxiflora	loose-flowered bluegrass
		Salix sessilifolia	soft-leaved willow
		Trillium parviflorum	small-flowered trillium
	NON-VASCULAR	Iwatsukiella leucotricha	Iwatsukiella Moss
N. PUGET	**VASCULAR**		
		Carex comosa	bristly sedge
		Carex magellanica ssp. irrigua	poor sedge
		Carex pauciflora	few-flowered sedge
		Carex pluriflora	several-flowered sedge
		Carex stylosa	long-styled sedge
		Cimicifuga elata	tall bugbane
		Fritillaria camschatcensis	black lily
		Lobelia dortmanna	water lobelia
		Montia diffusa	branching montia
		Platanthera chorisiana	Choris' bog-orchid
		Utricularia intermedia	flat-leaved bladderwort
OESF	**VASCULAR**	Erythronium quinaultense	Quinault fawn-lily
		Erythronium revolutum	pink fawn-lily
		Plantago macrocarpa	Alaska plantain

		Poa laxiflora	loose-flowered bluegrass
	NON-VASCULAR	Iwatsukiella leucotricha	Iwatsukiella Moss
S. COAST	**VASCULAR**		
		Erigeron aliceae	Alice's fleabane
		Filipendula occidentalis	queen of the forest
		Packera bolanderi var. harfordii	Harford's ragwort
		Sericocarpus rigidus	white-top aster
		Trillium parviflorum	small-flowered trillium
	NON-VASCULAR	Iwatsukiella leucotricha	Iwatsukiella Moss
S. PUGET	**VASCULAR**	Githopsis specularioides	common bluecup
		Isoetes nuttallii	Nuttall's quillwort
		Lycopodiella inundata	bog clubmoss
		Ophioglossum pusillum	Adder's-tongue
		Polystichum californicum	California swordfern
		Utricularia intermedia	flat-leaved bladderwort
	NON-VASCULAR	Collema nigrescens	jelly lichen
		Hypogymnia heterophylla	tube lichen
STRAITS	**VASCULAR**	Carex pauciflora	few-flowered sedge
		Carex pluriflora	several-flowered sedge
		Chrysolepis chrysophylla var. chrysophylla	golden chinquapin
		Githopsis specularioides	common bluecup
		Montia diffusa	branching montia
		Whipplea modesta	Yerba de Selva
		Woodwardia fimbriata	giant chain fern
	NON-VASCULAR	Usnea longissima	beard lichen

Source: DNR Washington Natural Heritage database, accessed March 2016.

Appendix L. Wildlife Species and Associated Habitats in the Analysis Area

Table L- 1 Forest Habitat-Associated Wildlife Listed as State Endangered (SE), Threatened (ST), Sensitive (SS) and Candidate (SC) in the Analysis Area (excludes Federally-listed species, which are described in Section 3.5)

Species	Status	Primary Forest/Upland Habitat Association
Western Toad	SC	Requires riparian habitat for breeding
Northern Goshawk	SC	Mature and late-successional forests
Bald eagle	SS	Large trees for nesting, dense and mature forest stands for winter roosts
Cascade red fox	SC	Could occur in forest habitats
Fisher	SE	Structurally complex forest; large areas of contiguous forest; large snags and trees
Keens's Myotis	SC	Structurally complex stands; Caves, large snags and trees for roosting
Pileated woodpecker	SC	Structurally complex forest, large and medium snags
Peregrine falcon	SS	Forest habitats
Purple martin	SC	Snags near water, forest edges
Townsend's Big- eared Bat	SC	Caves for nesting
Vaux's Swift	SC	Large snags for nesting
Wolverine	SC	Upper elevation forested habitats

Based on WDFW Species of Concern List 2016

Table L-2 Species of Regional Importance

Species/Group	Importance	Habitat Association/ Known Important Areas (if any)
Deer and elk	Hunting, wildlife watching, cultural. Also, elk can damage agricultural crops in valleys, such as in the Skagit River Valley (Davison 2002).	Mix of ecosystem initiation stage forests for foraging and structurally complex forests for resting and cover. Lower road densities preferred (Spencer 2002, Davison 2002). Elk critical winter habitat located in lower major river valleys, including the Skagit, Green, White and Nisqually Rivers (WDFW 2016). Other known wintering areas are present in the South Coast planning unit (Willapa herd) and the Straits planning unit (Dungeness herd).
Black bear	Hunting, wildlife watching, cultural. Also economic importance related to bears feeding on and killing young conifer trees on lands managed for timber production (Ziegltrum 2004)	Dens in structurally complex forests, may feed in early and competitive exclusion stages.
Cougar	Hunting, wildlife watching, functioning ecosystems.	Closely related to deer and elk.
American marten	Indicator of functioning forest ecosystems.	Structurally complex forests.
Forest grouse	Hunting, wildlife watching.	Riparian and early stage forests, roadside and rights-of-way vegetation.
Forest owls (saw-whet, pygmy, western screech)	Wildlife watching, functioning ecosystems.	Structurally complex forests (Johnsgard 1998)
Red-tailed hawk, great horned owl and sharp-shinned hawk	Wildlife watching, functioning ecosystems.	High-contrast edge, recently harvested, rights-of-way (Johnsgard 1990).
Neo-tropical migratory songbirds	Wildlife watching, functioning ecosystems.	Early ecosystem initiation stage forests and later structurally complex stages. (Andelman and Stock. 1994, Washington State University Cooperative Extension No Date).

Appendix M. Data and Assumptions Used in Socioeconomics Analysis

The impact of marbled murrelet LTCS alternatives on trust revenue from timber sales depends on the anticipated harvest schedule under each alternative. The alternatives do not include a harvest schedule so a direct comparison of harvest levels cannot be made. DNR was able to compare the alternatives using two different methods, bare land value[1] and the change in estimated annual timber harvest revenue. Both methods required DNR to make assumptions about timber production and operability. The effects of the alternatives on a modeled harvest schedule will be analyzed as part of a financial analysis associated with the next sustainable harvest calculation.

A key assumption used in this analysis was the relative weighting of lands in different land classes. DNR used land classes to describe management constraints on different lands. Deferred lands are unavailable for harvest. The riparian land class is made up of riparian and wetland buffers. Uplands with general objectives are managed in accordance with the HCP and all other applicable law and polices, but are not subject to particular conservation strategies that limit harvest location or type. Uplands with special objectives are managed under all the same rules as upland with general objectives plus have additional constraints from the norther spotted owl, marbled murrelet or riparian conservation[2] strategies (Table M-2).

Table M-1. Acres deferred from harvest and acres available for harvest in each land class for each alternative.

Land Class	Alternative A (acres)	Alternative B (acres)	Alternative C (acres)	Alternative D (acres)	Alternative E (acres)	Alternative F (acres)
Deferred	452,736	413,234	473,693	468,189	478,573	552,174
Uplands with general objectives	423,942	436,088	420,058	417,710	418,460	401,355
Uplands with special objectives	284,754	299,361	272,939	277,589	270,483	231,667

[1] Bare land value (BLV) assess the present net worth of an infinite number of successive, identical timber harvest rotations. As calculated here, the resulting value does not include any indication of the value of non-timber or non-market values. Revenue sources other than timber harvests could be included in the calculation, if applicable. BLV is calculated as: $BLV = \frac{NFW}{(1+i)^n - 1}$ where NFW is the net future worth calculated as the sum of the future.

[2] The hydrologic maturity component of the riparian conservation strategy.

Riparian	216,056	228,795	210,790	213,991	209,964	192,283
Total	1,377,479	1,377,479	1,377,479	1,377,479	1,377,479	1,377,479

Estimating bare land value change

The first step in estimating bare land value change was to compare the number of acres deferred from harvest and acres available for harvest in each land class to Alternative A (Table M-2).

Table M-2. Change in acres deferred from harvest and acres available for harvest in each land class under Alternative A and B.

Land Class	Alternative A (acres)	Alternative B (acres)	Difference between Alt A and Alt B (acres)
Deferred	452,736	413,234	-39,501
Uplands with general objectives	423,942	436,088	12,739
Uplands with special objectives	284,754	299,361	14,616
Riparian	216,056	228,795	12,146
Total	1,377,479	1,377,479	0

DNR then assumed that, in the long run, uplands with special objectives have a bare land value equal to one third uplands with general objectives, and that riparian areas have a value equal to one thirty-third uplands with general objectives. These assumptions come from DNR's experience that uplands with special objectives have extended rotation lengths, and lower average volumes due to higher rates of thinning comparted to uplands with general objectives. Riparian harvests generate even lower volumes because most harvest activities are thinning and the area of harvested each year is small.

Determining the bare land value of an acre of uplands with general objectives required several assumptions:

- Costs incurred in management equals $300 per acre harvested, the cost of regeneration,
- The discount rate on all costs and revenue equals 5 percent per year,
- Harvest occurs at age 50 and yields 32 MBF per acre, consistent yield on DNR lands with site index class II land that have not been commercially thinned, and
- Stumpage is $350 per MBF.

Based on these assumptions the bare land value of one acre in the analysis area is $1,485. Multiplying this value by the land class weighting and the number of acres difference between alternatives results in the bare land value change (Table M-3). These estimates were developed for use in this DEIS only. Actual bare land value may be diffrerent.

Table M-3. Change in bare land value (BLV) between Alternative A and Alternative B.

Land Class	Difference between Alt A and Alt B (acres)	BLV per acre of uplands with general objectives	Weighting	Change in BLV (rounded to nearest 1000)
Deferred	-39,501	$1,485	0	0
Uplands with general objectives	12,146	$1,485	1	$18,036,000
Uplands with special objectives	14,616	$1,485	1/3	$7,235,000
Riparian	12,739	$1,485	1/33	$573,000
Total	**0**	**NA**	**NA**	**$25,844,000**

Estimating the change in annual timber sales revenue

To estimate the change in annual timber sale revenue, DNR calculated the change in acres available for harvest in each land class (Table M-2). DNR weighted each land class to find the change in operable acres available in each land class (Table M-4). DNR assumed that stand in the lands that change land class are equally distributed across ages 1 to 50 years old such that one fiftieth of the acres would be harvested year. DNR also assumed:

- Harvests yield 32 MBF per acre, consistent yield on DNR lands with site index class II land that have not been commercially thinned, and,
- Stumpage is $350 per MBF.

Multiplying the annual acres of harvest by the yield and stumpage results in the estimated annual revenue change (see Box 1, below). The actual change in timber sale value would depend on timing of harvest, volume, timber quality, and stumpage price.

Table M-4. Change in Operable Acres between Alternative A and Alternative B.

Land Class	Difference between Alt A and Alt B (acres)	Weighting	Change in operable acres
Deferred	-39,501	0	0
Uplands with general objectives	12,146	1	12,146
Uplands with special objectives	14,616	1/3	4,872
Riparian	12,739	1/33	386
Total	**0**	**NA**	**17,404**

Box 1. Estimated change in annual timber sale revenue due to Alternative B.

Change in operable acres harvested annually x Yield x Price = Change in annual timber sale revenue

Appendix N. Distribution List

This appendix provides the distribution list for the draft Environmental Impact Statement (DEIS) for a Marbled Murrelet Long-Term Conservation Strategy.

Federal Agencies

National Oceanic and Atmospheric Administration
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

State Agencies

Department of Archaeology and Historic Preservation
Department of Ecology
Department of Fish and Wildlife
Department of Labor and Industries
Department of Parks and Recreation
Department of Revenue
Department of Transportation

Counties

Clallam County
Cowlitz County
Grays Harbor County
Island County
Jefferson County
King County
Kitsap County
Lewis County
Mason County
Pacific County
Pierce County
San Juan County
Skagit County
Snohomish County
Thurston County
Wahkiakum County
Whatcom County

Cities

City of Aberdeen
City of Algona
City of Anacortes
City of Arlington
City of Auburn
City of Bainbridge Island
City of Battle Ground
City of Bellevue
City of Bellingham
City of Black Diamond
City of Blaine
City of Bonney Lake
City of Bothell
City of Bremerton
City of Buckley
City of Burien
City of Burlington
City of Camas
City of Carnation
City of Castle Rock
City of Centralia
City of Chehalis
City of Clyde Hill
City of Cosmopolis
Town of Coupeville
City of Covington
City of Duvall
City of Edgewood
City of Edmonds
City of Elma
City of Enumclaw
City of Federal Way
City of Fife
City of Fircrest
Town of Friday Harbor
City of Gig Harbor
City of Hoquiam
City of Hunts Point
City of Kelso
City of Kenmore
City of Kirkland
Town of La Conner
City of Lacey
City of Lake Forest Park
City of Lake Stevens
City of Lakewood
City of Langley
City of Long Beach
City of Longview
City of Lynden
City of Lynnwood
City of Maple Valley
City of Marysville
City of McCleary
City of Medina
City of Mercer Island
City of Mill Creek
City of Milton
City of Monroe
City of Montesano
City of Mountlake Terrace
City of Mukilteo
City of New Castle
City of Normandy Park
City of Oak Harbor
City of Ocean Shores
City of Olympia
City of Orting
City of Pacific
City of Port Orchard
City of Port Townsend
City of Poulsbo
City of Puyallup
City of Redmond
City of Renton
City of Ridgefield
City of Sammamish
City of Seattle
City of Sedro-Woolley
City of Sequim
City of Snohomish
City of Snoqualmie
City of South Bend
Town of South Prairie
City of Stanwood
City of Sultan
City of Sumas
City of Tacoma
City of Tukwila
City of University Place
City of Washougal
City of Westport
City of Woodinville
City of Yelm

Tribes

Coeur d'Alene Tribe
Columbia River Intertribal Fisheries Commission
Colville Confederated Tribes
Confederated Tribes of the Chehalis
Confederated Tribes of the Colville Reservation
Cowlitz Indian Tribe
Duwamish Tribe
Hoh Tribe
Jamestown S'Klallam Tribe
Kalispel Tribe
Kootenai Tribe of Idaho
Lower Elwha Klallam Tribe
Lummi Nation
Makah Tribe
Muckleshoot Tribe
Nez Perce Tribe
Nisqually Tribe
Nooksack Tribe
Northwest Indian Fisheries Commission
Point No Point Treaty Council
Port Gamble S'Klallam Tribe
Puyallup Tribe
Quileute Nation
Quinault Nation
Samish Indian Nation
Sauk-Suiattle Tribe
Shoalwater Bay Tribe
Skokomish Tribe
Snoqualmie Indian Tribe
Snoqualmie Indian Tribe
Spokane Tribe
Squaxin Island Tribe
Stillaguamish Tribe
Suquamish Tribe
Swinomish Tribe
The Confederated Tribes of the Umatilla Nation
Tulalip Tribes
Upper Columbia United Tribes
Upper Skagit Tribe
Warm Springs Confederated Tribes
Yakama Nation

Organizations

Admiralty Audubon Chapter
American Forest Resource Council
Black Hills Audubon Society
Blue Mountain Audubon Society
Chamber of Commerce
Columbia River Keeper
Conservation Northwest
Earth Ministry
Friends of the Columbia Gorge
Gifford Pinchot Task Force
Hampton Affiliates
Kitsap Audubon Society
Kittitas Audubon Society
North Cascades Audubon Society
North Central Washington Audubon Society
Olympic Forest Coalition / Sierra Club
Olympic Coast Alliance
Olympic Peninsula Audubon Society
People for Puget Sound
Perkins Coie (representing Columbia River Alliance for Nurturing the Environment)
Pilchuck Audubon Society
Rainier Veneer
San Juan Islands Audubon Society
Seattle Audubon
Sierra Club
Sierra Pacific Industries
Skagit Audubon Society
Skagit River Systems Cooperative
Spokane Audubon Society
Tahoma Audubon Society
The Villa
The Wilderness Society
Vancouver Audubon Society
Washington State Association of Counties
Wahkiakum County Eagle
Washington Contract Loggers Association
Washington Forest Law Center
Whidbey Environmental Action Network
Washington Environmental Council
Washington Hardwoods Association
Washington Forest Protection Association
Whidbey Island Audubon Society
Willapa Hills Audubon Society
Willapa Hills Audubon Society Grays Rive

Academia

Central Washington University Library
Columbia Basin College Library
Centralia College Library
Clark College Library
Edmonds Community College Library
Everett Community College Library
Evergreen State College Environmental Resource Center
Green River Community College Holman Library
Gonzaga University Library
Grays Harbor College John Spellman Library
Highline Community College Library
Heritage College Library
Highline Community College Library
Lower Columbia College Alan Thompson Library
North Seattle Community College Library
Olympic College Learning Resource Center
Pacific Lutheran University Library
Pierce College Ft. Steilacoom Technical Service Library
Saint Martins University Library
Seattle Community College District Library
Seattle Pacific University WGER Memorial Library
Seattle University Lemieux Library
Shoreline Community College Ray W Howard Library
Skagit Valley College Library
South Puget Sound Community College Library
South Seattle Community College Library
Spokane Community College Library
Tacoma Community College Library
University of Puget Sound Collins Memorial Library
Walla Walla Community College Library
WA State University Environmental Science Library
Wenatchee Valley College Library
Whatcom Community College Learning Resource Center
Whitman College Penrose Library
Whitworth College Library
WWU Library
WWU Huxley College Environmental Resources Library
Yakima Valley Community College Library

Libraries

Aberdeen Timberland Regional Library
Burlington Public Library
Cathlamet City Library
Centralia Timberland Library
Chehalis Timberland Library
Chelan Public Library
Cheney Public Library
Chewelah Public Library
Clark County Law Library
Cle Elum Public Library
Colville Public Library
Dayton Public Library
Ellensburg Public Library
Enumclaw Public Library
Ephrata Public Library
Everett Public Library
Fairwood Library
Fort Vancouver Regional Library
Goldendale Public Library
Grand Coulee Public Library
Grandview Community Library
Harrington Public Library
Hoquiam Timberland Library
Issaquah Library
James River Corp Camas Technical Center Library
John A Brown Library
Jefferson County Rural Library District
Kelso Public Library
Kettle Falls Public Library
King County Library System
Kitsap Regional Library
Kittitas Public Library
Lacey Timberland Library
Longview Public Library
Mid Columbia Library
Mount Vernon Public Library
North Central Regional Library
North Olympic Library System
Okanogan Public Library
Omak Public Library
Othello Public Library
Pasco Public Library
Pierce County Library
Pomeroy Library
Port Townsend Public Library
Prosser Public Library
Pullman Public Library
Puyallup Public Library
Reardan Memorial Library
Renton Public Library
Richland Public Library
Ritzville Public Library
Roslyn Public Library
San Juan Island Library
Seattle Public Library
Sedro-Woolley Public Library
Sno Isle Regional Library
South Bend Timberland Library
Spokane County Library
Spokane Public Library
Sprague Public Library
Timberland Regional Library
US Environmental Protection Agency Library
US Forest Service Library
Waitsburg Weller Public Library
Walla Walla County Library
Wenatchee Public Library
Whitman County Library
Wilbur Public Library
William G Reed Timberland Library
WA State Library
Yakima Valley Regional Library

Individuals

Hon. Derek Kilmer, Member of Congress
Hon. Jaime Herrera Buetler, Member of Congress
Andy Ingram
David Galle
Dixon Haynes
Gordon Iverson
Ivar Dolph
Jeff Hauenstein
Jen & Mike Sevigny
Ryan Ojerio
Joanne Lennox
Josey Paul
Kathleen Snyder
Leigh McKeirnan
Llyn Doremus
Miguel Perez-Gibson
Mike Hicks
Paul Kriegel
Rod Fleck
Tom Hamer
Tom Hicks
Paul Friesema
Al & Kate Werner
Craig Hansen
Jaclyn Bringuez
Laura Merrill
Marilyn Sandall
Matt Mega
Toby Thaler
Art Wang
Bev Bassett
Bill Monahan
Charlotte Persons
Deanna Lynch
Derek Poon
Janet Anthony
Jill Silver
Brian Bailey
Lloyd Fetterly
Marieke Rack
Marty Raphael
Matthew Longenbaugh
Mike Haggerty
Taylor Goforth
Stephen Kropp
Harold Chesnin
Paul Bialkowsky
Doug Cooper
Randy Bartelt
Michael Foster
Greg Eide
Kimberly LaDuca
Lisa Remlinger
Greta Holmstrom
Chris Brong
Bob Forsberg
Linda Murtfeldt
Beth Johnson
Joe Monks
Marc Heileson
Jen Syrowitz
Jerry Johannes
Robert Coty
Bill Turner
Dave Ivanoff
Dave Sweitzer
Jean Public
Jerry Bonagofsky
Ken Maurer
Knox Marshall
Mark Bosetti
Mike Davis
Carol Johnson
Steve Courtney
Teresa Kubo
Will Miller
Madora Boyd
Michael Marthaller
Allison Ostrer
Andrea Maxand
Anita Das
Ann Stockdale
Arif Vega
Bay Renaud
Brian Davis
Carol Warneke
Catherine Ruha
Charles and Kathleen Hiatt
Charles Ring
Dianna Moore
Donna Hanson
Edward Vaughn
Elaine Dolan
Elaine Malone
Elizabeth Garner
Elizabeth Stucki
Felicia Dale
Glen Anderson
Grant Bowen
Helen Curtis
Jack Jensen
Janet Jordan
Janette Hursh
Janice Marshall
Janice Wieser
Jill Heishman
Jimmy Malecki
Joanne Roberts
Joe Chasse
John Tuxill
Johnny Townsend
Judy Larson
Karen Grooms
Karen Hartman
Karen Mottet
Kristina Miller
Laura Sutkus
Lehman and Barbara Holder
Linda Hines
Linda Romero
Lisa Werner

Lori Erbs
Marjorie Parkis
Mark Sawyer
Mary Bicknell
Mary Mahar
Nancy Jacobs
Nita Hildenbrand
Pamela Negri
Patty Bowen
Paul Heineck
Paula Rotondi
Randy Goggin
Richard Curtis
Robert Grimm
Robert Sendrey
S. Nelson
Shawn Deyell
Shawn Olsen
Susan Ahlschwede
Thelma Follett
Vicki Dopps
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April Atwood
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Vincent Lambert
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