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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 when necessary.

Identifying Impacts

Because the alternatives are limited to evaluating different approaches for marbled murrelet conservation, identifying adverse impacts to other natural resources can be challenging. By design, the alternatives do not propose changing any management approaches other than the marbled murrelet conservation strategy. Considerable adverse impacts to other resources therefore are not expected. Nevertheless, subtle, indirect, and/or cumulative impacts can occur to natural resources due to the varying degrees of conservation proposed for marbled murrelets under the alternatives. This chapter will assess the impacts that 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 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 also are evaluated.

Evaluation criteria rely on the existing conservation or management objectives, policies, or rules that are currently implemented 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 revised draft environmental impact statement (RDEIS) is designed to meet the requirements of both the State Environmental Policy Act (SEPA) and National Environmental Policy Act (NEPA). Both laws require the RDEIS 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 approximately 1.38 million acres of lands managed by the Washington State Department of Natural Resources (DNR). 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 in the context of available recreation facilities in the analysis area, but may be significant when considered locally. Most alternatives are evaluated at the scale of the analysis area (analysis area scale), although some impacts are evaluated at the planning unit or county scale when appropriate data is available to measure the potential impact.

Considering Intensity

The term "intensity" refers to the severity of the impact. Intensity is affected by 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 also are 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 *State Trust Lands Habitat Conservation Plan* (1997 HCP).

Scale of Analysis

As described in Chapter 1, this RDEIS considers DNR activities at the strategic level of planning. The scale of analysis for negative impacts to soils and landslide hazards is the analysis area, with 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

Because timber harvest activities are limited in areas of long-term forest cover, 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 long-term forest cover. However, even with the reduction of approximately 24,000 acres of long-term forest cover under Alternative B (compared to the no action alternative), all existing policies and regulations governing forest practices for soil productivity would remain in place. These policies and regulations also would apply to any area that is currently protected as marbled murrelet habitat under the interim strategy but may become available for management depending on which alternative is selected.

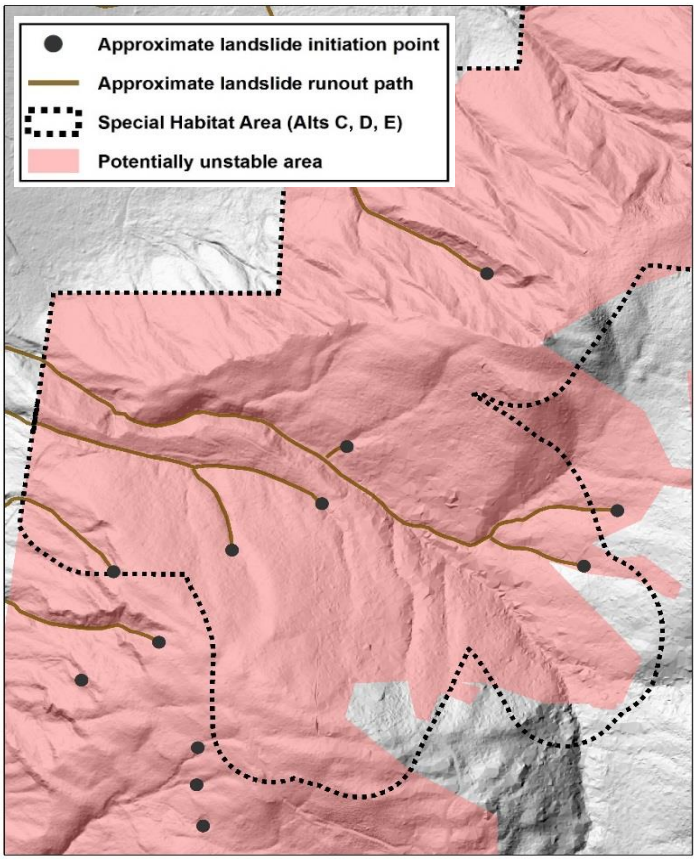
Standard Best Management Practices to Minimize Erosion Include Placing Crushed Surface Rock on Roads. Photo: DNR

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. However, mapped potentially unstable areas are not definitely at risk of a landslide occurring during the planning period.

Figure 4.1.1 illustrates a proposed special habitat area that overlaps an area indicated as potentially unstable in DNR's

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



geographic information system (GIS). 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 most likely. 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 under current regulations, policies, and procedures, which are designed to minimize landslide risks. For these reasons, landslide risk is not expected to increase compared to current conditions, even on the 24,000 additional acres made available for active management under Alternative B (as compared to 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 24,000 additional acres available for active management under Alternative B, DNR would continue to minimize the potential for landslides and damaging impacts to soils through the existing regulatory framework. Some areas of potential slope instability or high erosion potential would be included in marbled murrelet conservation areas, but active management 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 long-term forest cover under each alternative. Acres of potentially unstable slopes. Percentage of long-term forest cover that is potentially unstable. Percentage of potentially unstable slopes in interior forest.	None. No alternative would increase risks to soils or landslide potential. Compared to the no action alternative, Alternative B increases the acreage available for active management, including road building, by 24,000 acres, 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

This analysis examines if the net amount of carbon sequestered in both forested stands and harvested wood is projected to be greater than the amount of carbon emitted from the burning or decay of harvested wood. For this analysis, DNR follows the methodology described in *Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States* (Smith and others 2006), which is also described in the *Olympic Experimental State Forest HCP Planning Unit Forest Land Plan Final Environmental Impact Statement* (DNR 2016d). This carbon method estimates the amount of carbon sequestered in forested stands and soil and the amount of carbon sequestered and emitted from harvested wood over time. Region-specific estimates found in Smith and others 2006 were used in the analysis.

The analysis to determine whether the alternatives exacerbate the impacts of climate change on the environment uses two generalized categories of DNR-managed lands: those that are managed on a long-term basis to maintain forest cover for conservation, and those that are managed for revenue production, primarily through harvesting. In addition, when discussing vegetation, the analysis considers two key capabilities of natural systems, resistance and resilience. Resistance is defined as the ability to delay or prevent change. Resilience is defined as the capacity of a system to experience a stand-replacing disturbance without shifting to an alternative ecosystem state over the long term (adapted from Walker and others 2004). The analysis considers whether the action alternatives will result in a loss of resistance or resilience by elements of the environment as compared to the no action alternative.

Greenhouse Gas Emissions and Carbon Sequestration

Text Box 4.2.1. Do the Alternatives Influence Carbon Sequestration?

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

For the 2016 draft EIS (DEIS), DNR did not have data on how much basal area[1] might be removed from each stand in the future, how much basal area would remain in each stand following a treatment, and how much carbon would be sequestered through time as each thinned or unharvested stand grows. Without such data, a quantitative analysis was difficult and would likely have produced questionable results. However, since the 2016 DEIS, DNR released the *Alternatives for Establishment of a Sustainable Harvest Level for Forested State Trust Lands in Western Washington Draft Environmental Impact Statement* (sustainable harvest DEIS [DNR 2016d]). The sustainable harvest DEIS integrated the effects of the marbled murrelet long-term conservation strategy alternatives with other policy decisions. The sustainable harvest DEIS analyzed carbon sequestered and emitted for each alternative based on modeled projections of both timber removal and tree growth.

While this RDEIS includes two new alternatives (Alternatives G and H), both new alternatives are within the range of alternatives evaluated in the sustainable harvest DEIS. Therefore, the carbon analysis conducted for the sustainable harvest DEIS include the ranges of carbon sequestered and emitted under all old and new alternatives examined in this RDEIS.

As described in detail below, this analysis concludes that all alternatives are likely to result in more carbon sequestered than emitted over a five-decade period.

Climate-Related Effects on Elements of the Environment

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

Scale of Analysis

Carbon sequestration and emission is analyzed at the scale of the analysis area. This scale is appropriate because a determination of net carbon emissions for each alternative must consider both the carbon sequestered in the entire analysis area and the emissions from managing the same area.

[1] The cross-sectional area of all stems in a stand measured at breast height, expressed in square feet per acre.

The analysis to determine whether the alternatives exacerbate the impacts of climate change on the environment also is done at the scale of the analysis area. While climate will influence the future forests of Washington, including those on DNR-managed lands, climate projections and current understanding of individual tree species responses are not sufficiently robust to be applied at the stand level, although some research is trending in this direction (Lenior and others 2017) and broad adaptation strategies in forest types like those found in western Washington have been proposed (Halofsky and others 2018, Halofsky and others 2011).

How Impacts Are Measured: Carbon Sequestration

CARBON SEQUESTERED IN FORESTS

Many components of forests store carbon. In the scientific literature, elements of the environment that store carbon are called "pools." All forest-related carbon pools analyzed in this chapter are described in Table 4.2.1. Each pool was calculated separately based on the unharvested tree volume, which was estimated from DNR's sustainable harvest model and projected over time. All forest-related carbon pools were summed together.

Table 4.2.1. Pools of Carbon Stored in Forest Stands (Adapted From Smith and Others 2006)

Forest stand carbon pools	Description
Live trees	Live trees with a diameter at breast height of at least 1 inch; includes tree trunk, coarse roots, branches, and foliage.
Standing dead trees	Standing dead tree with a diameter at breast height of at least 1 inch; includes tree trunk, coarse roots, and branches.
Understory vegetation	Live vegetation; includes shrubs, bushes, tree trunks, roots, branches, and foliage of seedlings (trees less than 1-inch diameter at breast height).
Downed dead wood	Logging residue and other downed woody debris; includes woody material larger than 3 inches in diameter, stumps, and the coarse roots of stumps.
Forest floor	Organic material on forest floor; includes fine woody debris up to 3 inches in diameter, tree litter, humus, and fine roots in the organic layer of the forest floor above the mineral soil.
Soil organic carbon	Below-ground carbon without coarse roots; includes fine roots and all other organic carbon not included in other pools to a depth of 3 feet.

CARBON SEQUESTERED IN HARVESTED WOOD

When trees are harvested, some of the carbon they contain remains on site (for example, as slash or stumps, which decay over time) and some is removed as cut timber. Wood that is removed from the site is made into a variety of wood-based products, such as paper or lumber for homes and furniture.

Wood-based products sequester carbon for varying lengths of time. For example, paper may sequester carbon for only a short time if it is discarded after use or burned. However, paper can last longer if it is stored in books or magazines or recycled. Items made from wood, such as houses or furniture, also can sequester carbon for a long time (Smith and others 2006). Products made from wood are eventually discarded and placed in a landfill, where they are covered and decay slowly (Ryan and others 2010). In this analysis, harvested wood is calculated as two carbon pools to reflect different pathways by which

carbon from harvest can be sequestered (Table 4.2.2). While calculated separately, both carbon pools are summed together in the figures and table found in the sustainable harvest DEIS.

Table 4.2.2. Pools of Carbon Stored in Harvested Wood (Adapted From Smith and Others 2006)

Harvested wood carbon pools	Description
Products in use	Wood that has not been discarded or destroyed, such as houses and other buildings, furniture, wooden containers, paper products, and lumber. Carbon stored in this pool is relatively stable but eventually is discarded to landfills.
Landfills	Wood that has been discarded and placed in landfills. Carbon is emitted to the atmosphere slowly because of slow decay rates.

CARBON EMITTED FROM HARVESTED WOOD

Carbon is emitted from harvested wood through burning or decay. If burned, the energy released may be captured to warm a home or generate electricity. In this analysis, carbon emissions arise from two distinct carbon pools, which are described in Table 4.2.3. Irrespective of carbon pool, it is assumed that carbon emissions from a tree begin the same year the tree is harvested. For example, Smith and others (2006) assumes that 26 percent of carbon in a saw log and 50 percent of carbon in pulpwood is emitted in the same year a softwood tree is harvested. This analysis uses the same assumption. Total carbon emitted from that harvested tree increases with time, but the rate of emissions will vary depending on factors such as the species harvested (hardwood or softwood) and whether the harvested tree is used as a saw log or pulpwood.

Table 4.2.3. Sources of Carbon Emissions From Harvested Wood (Adapted From Smith and Others 2006)

Harvested wood carbon source	Description
Emitted with energy capture	Wood products are burned and the energy is captured or used. For example, wood is burned in a fireplace, and the energy (heat) is captured in the home for a period of time (Ryan and others 2010). Another example of energy capture from wood products is if wood is burned to generate electricity, which is referred to as biomass energy. Biomass energy is used primarily by the forest products industry to run sawmills.
Emitted without energy capture	Wood products are burned intentionally or accidentally, and no effort is made to capture or use the energy, such as a house fire or burning trash. Another example is the natural decay of wood products. Wood products that are exposed to weather and decay fungi will eventually decompose, with rates of decomposition varying by type of wood product, size, and site conditions.

CARBON EMITTED FROM LAND-MANAGEMENT ACTIVITIES

Carbon is emitted due to direct and indirect use of fuel and energy when managing forests. For example, fuel is used by equipment during harvest operations and for electricity to power greenhouses where seedlings are grown prior to planting in the harvest units.

A carbon analysis by Sonne (2006) examined such sources for lands managed for rotation forestry in western Oregon and Washington. In the analysis, Sonne modeled greenhouse gas emissions from 107 different management scenarios that varied in assumptions around the seedling type grown, site preparation used, growth enhancement treatments implemented, and rotation age. Because no single scenario modeled was representative of DNR-managed lands, this analysis uses the average greenhouse gas emissions reported by Sonne 2006 across all modeled scenarios of 9.8 tonnes of CO_2 equivalent per hectare (or 1.08 tonnes of carbon per acre) over a 50-year rotation period. This emission value was applied to the total area harvested and thinned per decade.

■ Summary of Direct, Indirect, and Cumulative Impacts

Greenhouse Gas Emissions and Carbon Sequestration

In DNR's sustainable harvest DEIS, more carbon was sequestered than emitted over a five-decade period under each analyzed alternative. Compared to each other, differences in the net amount of carbon sequestered across all alternatives were small (DNR 2016d).

Text Box 4.2.2. 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.

Alternative B, under which the least amount of long-term forest cover is conserved, is most similar to Alternative 2 in the sustainable harvest DEIS, which projects the greatest amount of harvest across all alternatives.[2] According to the sustainable harvest DEIS, Alternative 2 sequestered 1.4 percent less carbon than the no action alternative over 50 years. Alternative F, which conserves the most long-term forest cover, is most similar to Alternative 5 in the sustainable harvest DEIS. According to the sustainable harvest DEIS, Alternative 5 sequestered 1 percent more carbon than the no action alternative over 50 years. While this RDEIS includes two new alternatives (G and H), which were not modeled in the sustainable harvest DEIS, neither new alternative conserves as much long-term forest cover as Alternative F, nor do the alternatives release as much long-term forest cover as Alternative B. Because both alternatives fall within the range of alternatives modeled in the sustainable harvest DEIS, this analysis concludes that the two new alternatives will also sequester more carbon than emitted over a five-decade period. While the amount of carbon sequestered will increase with long-term forest cover area, this analysis also concludes that none of the alternatives is likely to result in a significant adverse impact to climate change from emissions because all alternatives sequester more carbon than is emitted.

[2] The sustainable harvest DEIS considers arrearage harvest levels and riparian harvest levels. Both of these policy considerations have little effect on carbon sequestration over the 50-year analysis period since they have only a small impact on the volume harvested over that period, compared to the effect of the marbled murrelet long-term conservation strategy alternatives.

Impacts of Climate Change on Elements of the Environment Critical to a Long-Term Conservation Strategy

VEGETATION

Text Box 4.2.3. 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 westside 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.

Growth and retention of structurally complex forest throughout the planning period is key to the success of a long-term conservation strategy. Forest growth (productivity) is affected by climate change. For reasons noted in Section 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 areas. Overall, it is not yet possible to conclude when climate-related influences to forest productivity on DNR-managed lands within long-term forest cover will be positive, negative, or neutral through the planning period. No significant productivity differences are anticipated within long-term forest cover between the no action alternative and the action alternatives, nor between action alternatives.

Forest conditions can be changed through management. Thinning to accelerate late-successional conditions in younger second-growth forests could increase forest resilience by reducing drought-related stress in younger and more moisture-sensitive trees, and by fostering 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 the stand scale (since older forests have the broadest range of tree sizes and species) (Halofsky and others 2018). Thinning will occur in long-term forest cover on a limited basis, consistent with conservation measures described in Table 2.2.5, 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 affected and continue to affect coastal Washington forests, but their influence in the rest of western Washington is more muted. Projections for western

Washington do not point conclusively to increases or decreases in the intensity of windstorms in the future (Warner and Mass 2017; Warner et al. 2015).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 both adapted and resilient to stand-replacing disturbance regimes (Halofsky and others 2018). 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 (for example, forestall change) and resilience under a changing climate (Halofsky and others 2018). 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 rather than few, large patches will better increase the probability that some habitat will persist when a wildfire occurs (which will eventually happen). Therefore, alternatives that conserve older forest, such as murrelet habitat, across DNR-managed lands will provide greater resistance and resilience than those alternatives that concentrate conservation of older forest in one or a few areas. 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 (Halofsky and others 2018).

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 is 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 likely will 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 Section 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 little difference in impacts due to climate change to vegetation is expected between the action alternatives and the no action alternative, and little difference is expected between action alternatives. Based on this conclusion, little difference in impacts 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 murrelets or other listed wildlife is expected between the action alternatives and the no action alternative, nor between action alternatives outside of Alternative F. Alternative F is likely to have the lowest climate change impact on the marbled murrelet and other older-forest associated species because of the substantial increase in total long-term forest cover acres (a 142,000 acre increase relative to the Alternative A). This increase in long-term forest cover area results in the most interior forest and largest habitat patches. Climate change impacts on the marbled murrelet are more specifically discussed in Chapter 5.

Conclusions

This analysis has determined that retaining more area in long-term forest cover sequesters more carbon, and well-distributed habitat increases the resilience and resistance of vegetation to a changing climate and disturbance regime.

The analysis also determined that all alternatives sequester more carbon than emitted over a five-decade period. Compared to each other, differences in the net amount of carbon sequestered across all alternatives was small.

All alternatives distribute long-term forest cover across the analysis area. Other than Alternative B, all alternatives increase long-term forest cover area relative to the No Action alternative, increasing likely long-term forest cover resilience, resistance, and persistence to a changing climate. Potential impacts from climate change on long-term forest cover are likely lowest for Alternative F, owing to its addition of 142,000 acres of long-term forest cover relative to the no action alternative. Alternatives C, D, E, G and H also all increase long-term forest cover area relative to Alternative A. Yet relative to Alternative A, Alternatives C, D, E, G and H will likely provide a similar benefit from a climate change perspective, with a maximum difference of approximately 43,000 acres of long-term forest cover across all six alternatives (including Alternative A). Any reduction in resilience to climate change impacts is probably slight under Alternative B, with a 24,000 acre decrease in long-term forest cover 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 likely will result in a net increase of greenhouse gas emissions or exacerbate impacts to elements of the environment from climate change.

Table 4.2.4. 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 over a five-decade period.	Carbon sequestered and emitted.	Sequestration is greater than emissions across all alternatives.
What effects will climate change have on the action alternatives or their expected environmental impacts?	Whether conservation or management approaches in long-term forest cover exacerbate climate change impacts or reduce climate-related resilience.	Differences in amount of long-term forest cover. 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 H are expected to increase resilience of long-term forest cover 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,[3] 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 in which vegetation management could be impacted by the alternatives.

How Impacts Are Measured

Data on forest conditions are used to qualitatively assess whether forests in long-term forest cover in the action alternatives are at any higher risk to forest health issues than forests in long-term forest cover under 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.

[3] A gene pool reserve is a naturally regenerated, Douglas-fir stand that DNR has deferred from harvest to ensure that native genetic material, well-adapted to local conditions, will be available to DNR in the future.

Summary of Direct, Indirect, and Cumulative Impacts

Based on the following analysis, no significant adverse effects are expected to general forest conditions as a result of the action alternatives. Some positive impacts are expected to wildlife species that benefits from older forest conditions.

Stands With High Relative Density

There is little difference in the area of forest with high relative density[4] (RD >85) in long-term forest cover between Alternative A and the action alternatives, compared to the total acres of long-term forest cover (Table 4.3.1).

Where thinning can occur in stands with high relative density, a short-term risk of disturbance may develop (Mitchell 2000). Under the action alternatives, thinning in long-term forest cover 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 of disturbance 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 Acres of Stands with High Relative Density (RD>85) in Long-Term Forest Cover 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	Alt. G	Alt. H
RD >85	92,000	-6,000	-1,000	-3,000	0	13,000	3,000	-2,000

For wildlife species benefitting from older forest conditions, a beneficial impact is expected in long-term forest cover due to more acres being in a protected status (refer to Section 3.5).

DNR-management and land use activities outside of long-term forest cover will 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 RDEIS. Therefore, forest conditions outside long-term forest cover are expected to be unaffected by the action alternatives.

[4] Relative density represents how the density (degree of crowding) of a given stand relates to the theoretical maximum density for a particular tree species.

Forest Health Risks

As described in Chapter 3, DNR, in conjunction with the US Forest Service, conducts annual aerial forest health surveys (Betzen and others 2017). The 2017 survey detected several sources of damage to forests in the analysis area, mostly from insects and bears. Forest damage occurs 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 long-term forest cover. 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. Thus root disease is not expected to pose a specific risk to marbled murrelet habitat.

Vegetation in Special Management or Conservation Status

Long-term forest cover 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 forests and gene pool reserves would be unchanged by any alternative. Potential impacts to rare plants already are 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 likely would get an indirect conservation benefit if they were located within a marbled murrelet conservation area that is protected from active forest management (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 U.S. Fish and Wildlife Service (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 if they were not acquired when DNR acquired the property.

Where special habitat areas overlap with natural area preserves and natural resources conservation areas, some minor impacts can be expected. Alternative D proposes 991 acres of special habitat areas that overlap natural area preserves and over 2,700 acres that overlap natural resources conservation areas. Because Alternative D proposes prohibiting facility and trail development in special habitat areas, development of future trails in some natural areas could be impacted (although there are no specific trail plans within these areas and within special habitat areas at this time). Alternative E includes 458 acres of natural area preserves within its designated special habitat areas and about 2,500 acres in natural resources conservation areas. Alternative H includes about 1,100 acres of natural area preserves and about 2,600 acres of natural resources conservation areas in special habitat areas. Both of these alternatives include a proposed conservation measure for trail development that is more flexible than under this Alternative D. Non-motorized trail development may occur on some natural resources conservation areas for environmental education or low-impact recreation purposes. Motorized trails or uses are not allowed in natural area preserves or natural resources conservation areas.

Forest restoration treatments are planned for several coastal natural areas (Bone River and Niawiakum River natural area preserves, Ellsworth Creek and Elk River natural resources conservation areas). 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.

Table 4.3.2. 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 stands with high relative density (RD >85).	No increase in area of forest health concerns expected. Minimal change in area of stands with high relative density under the action alternatives.
Do any alternatives affect the conservation status of rare plants, old-growth forests, or gene pool reserves?	Conservation policies in the *Policy for Sustainable Forests*, Olympic Experimental State Forest (*OESF) HCP Planning Unit 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 when they are included in marbled murrelet conservation areas and protected from active forest management.

Key questions	Criteria	Measures	Potential impacts
Do any of the alternatives affect the conservation objectives of natural areas?	RCW 79.70 and natural area preserve management plans; RCW 79.71 and natural resources conservation area management plans.	Planned projects on natural area preserves or natural resources conservation areas.	Alternatives D and E could limit the expansion or development of new low-impact trails for educational purposes in natural area preserves or natural resources conservation areas where special habitat areas overlap these lands. Forest restoration activities planned in natural area preserves or natural resources conservation areas might be affected by thinning limitations; however, 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 1997 HCP riparian conservation strategies to restore functioning riparian habitat?*

■ Evaluation Criteria

This section considers how proposed changes in long-term forest cover 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[5] 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 the 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 including the Forest Practices Act and Board Manual, SEPA, and 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 HCP Planning Unit 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 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).

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 analysis area.

[5] 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)

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.

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 and continue to provide large woody debris.

Example of Large Woody Debris. 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.

Stream in Peak Flow Condition. Photo: DNR

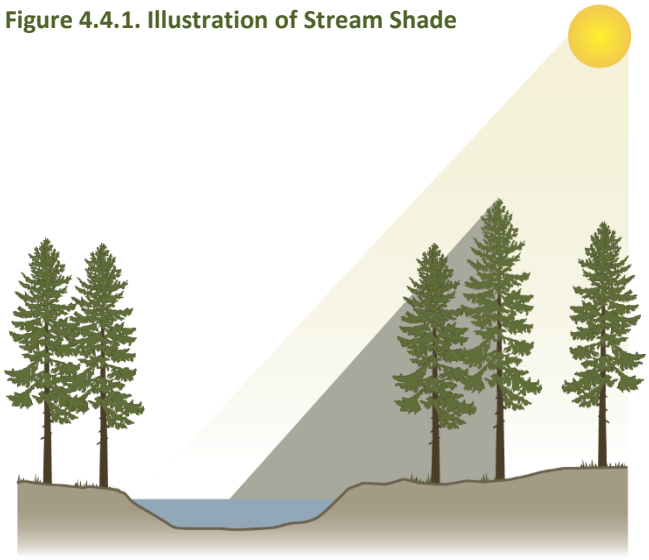
Alternatives C through H would increase long-term forest cover across the analysis area, which would have the potential to reduce peak flows, rather than increase them.

While Alternative B results in less long-term forest cover than the no action alternative, it does not alter DNR's existing approach to address peak flows through 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) (refer to Figure 4.4.1).

Figure 4.4.1. Illustration of Stream Shade



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.

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 be needed to avoid marbled murrelet habitat impacts. However, none of the action alternatives would alter existing forest practices regulations or 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 other waters.

LEAF AND NEEDLE LITTER RECRUITMENT

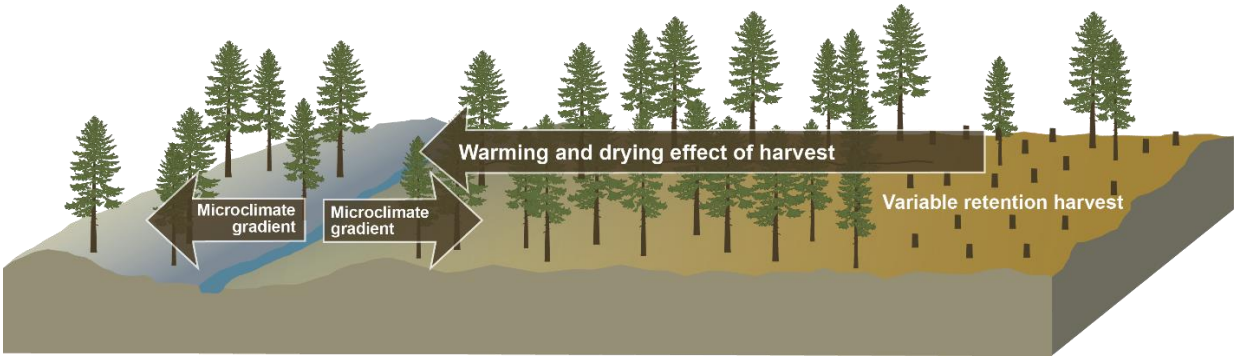
Leaf and needle litter are organic debris produced by the forest canopy that provide nutrients to streams that support the aquatic food chain. Leaf and needle litter accounts for the majority of nutrient inputs in small headwater streams and is critically important for the healthy function of these ecosystems (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 (Forest Ecosystem Management Assessment Team (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).

Figure 4.4.2. Timber Harvest Effects on Riparian Microclimate

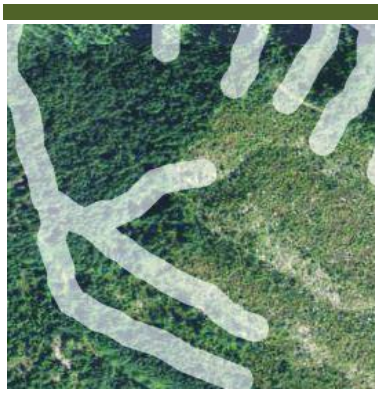


Studies by Brosofske and others (1997) demonstrated that streams exert a cooling effect on both soil and air temperatures at distances of up to 164 feet (50 meters) from the stream. In addition, they noted increased relative humidity at distances up to 122 feet (37 meters) from the stream. The heating and drying effects of harvest can extend up to approximately 545 feet (166 meters) into the surrounding unharvested areas (Chen 1991, Chen and others 1995, FEMAT 1993).

Timber harvest may occur well within this 545-foot (166-meter) zone of influence, potentially affecting the microclimate in adjacent areas of long-term forest cover. However, microclimate is a relatively small component of overall riparian health. Changes in microclimate are not expected to significantly affect riparian habitat function within long-term forest cover 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 analysis area (a 4 percent increase compared to current conditions under Alternative A). Under all other alternatives (Alternatives C through H), riparian management zones within the stringer configuration would decrease between 3 and 24 percent from current conditions in Alternative A. Forest cover adjacent to riparian habitat and associated microclimate function values would increase as forest stands within long-term forest cover mature.

Text Box 4.4.1. How do Isolated Riparian Areas Factor Into Aquatic Resource Impacts?



Long-term forest cover includes riparian areas that are less than 656 feet (200 meters) wide. These "stringers" are predominantly narrow riparian management zones where adjacent uplands have not been designated as long-term forest cover.

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 1997 HCP riparian conservation strategies and the RFRS, through which DNR implements the HCP westside riparian conservation strategy. Conservation measures proposed under the action alternatives would restrict harvest of riparian areas within occupied sites, occupied site buffers, marbled murrelet management areas (MMMAs), special habitat areas, and P-stage habitat greater than or equal to 0.47 identified in Alternatives C and E. Under Alternative G, no harvest of any P-stage value is allowed within the OESF HCP Planning Unit. These conservation measures prohibit thinning of riparian areas in the special habitat areas of Alternatives C, D, E, G, and H. Refer to Table 2.2.5 in Chapter 2 for details on thinning rules in conservation areas.

Since implementation of the RFRS, 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 the 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 long-term forest cover than the no action alternative).

Key questions	Criteria	Measures	Potential impacts
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 DNR's ability 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, E, G, and H could potentially delay some riparian management zones from reaching restoration objectives in these areas. This delay, 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 murrelet habitat 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

Could 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 do not experience adverse impacts from the alternatives.

Scale of Analysis

For this RDEIS, wildlife habitats and biodiversity are considered in terms of trends over the analysis area and through the planning period (five 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 *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 long-term forest cover 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 long-term forest cover 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 impacts pose little to no risk to overall species diversity (refer to Chapter 3 for a description of guilds).

INCREASE IN LONG-TERM FOREST COVER AND STRUCTURALLY COMPLEX FORESTS

All alternatives except Alternatives A and B would result in a net increase in long-term forest cover on DNR-managed lands. (Under Alternative A, which reflects current management practices, long-term cover would not increase from current conditions; under Alternative B, long-term cover would decrease 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 long-term forest cover, adding between 17,000 and 22,000 acres compared to the no action alternative. Alternative F would add the largest amount of long-term forest cover (142,000 acres), Alternative G would add 43,000 acres, and Alternative H would add the least at 10,000 acres. These increases may have local effects on wildlife habitats within special habitat areas, emphasis areas, and marbled murrelet management areas, where most additional long-term forest cover 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 long-term forest cover can be harvested, providing ecosystem initiation stage forests. Within long-term forest cover, areas available for harvest are reduced under all action alternatives except Alternative B. Alternative F would result in the greatest increase in long-term forest cover compared with the other alternatives, with an approximate increase of 24 percent (142,000 acres) in long-term forest cover compared to Alternative A.

INCREASED PATCH SIZE/DECREASED EDGE

The area of interior forest, defined as long-term forest cover at least 328 feet (100 meters) from any edge where active forest management may occur, decreases under Alternative B and increases under Alternatives C through H. Under Alternative B, the area of interior forest decreases by 16 percent. Increases under Alternative C through H range from 17 percent under Alternative H to 122 percent under Alternative F (refer to Figure 4.6.2 under "Marbled Murrelet" in this RDEIS for the increase in interior forest by landscape). This increase in interior forest is expected to benefit interior guild species (species that avoid edges or otherwise require large blocks of interior forest).

Increases in interior habitat will result in localized reductions of edge-associated species. However, all alternatives would maintain a majority of long-term forest cover 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 (April 1 through September 23), which would likely benefit other species of wildlife that breed during the same periods. Proposed conservation measures under the action alternatives also would result in changes to road construction, with most new road construction 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 through H.

All of these changes would potentially increase breeding and resting/hiding habitat for several sensitive species and reduce 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. At the scale of the analysis area, 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 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 affect bear population.

Increasing long-term forest cover, as would occur under Alternatives C through H, would increase the amount of structurally complex forest over time. Structurally complex 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 for deer or elk.

Text Box 4.5.1. How Will the Strategy Affect Elk Habitat?

Photo: WDFW

Elk feed in cleared areas but seek cover in forested areas. The proposed alternatives generally would increase cover habitat while decreasing foraging habitat. This effect would be in proportion to the amount of additional long-term forest cover 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.

BIRDS

Forest owls may benefit from long-term forest cover designation, although reductions in 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 long-term forest cover 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 warblers) and moderate decreases in species associated with ecosystem initiation stage forests (for example, willow flycatchers). However, similar other species discussed, there would be no significant impacts at the scale of the analysis area.

Table 4.5.1. Endangered Species Act-Listed Species and Potential for Adverse Impacts
E means Endangered, T Means Threatened

Species	Federal status	Potential for adverse impacts from marbled murrelet conservation alternatives
Columbian white-tailed deer (*Odocoileus virginianus leucurus*)	s	None. Habitats associated with the Columbian white-tailed deer are protected by the 1997 HCP riparian and wetland conservation 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 1997 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 protect 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 the 1997 HCP northern spotted owl conservation 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 conservation 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 by the 1997 HCP riparian and wetland conservation 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 by the 1997 HCP riparian and wetland conservation 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 conservation strategies.

Northern Spotted Owl

Under the alternatives, designated northern spotted owl conservation areas (nesting, roosting, and foraging and dispersal management areas) will not change in location. 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 HCP Planning Unit.

Alternative F differs from the other alternatives in that it includes mapped, low-quality northern spotted owl habitat (47,000 acres) in northern spotted owl conservation areas and each of the landscapes in the OESF HCP Planning Unit [6] in long-term forest cover. DNR will still be able to perform variable density thinning and other silvicultural treatments in these areas to enhance future northern spotted owl and marbled murrelet habitat, so including this habitat in long-term forest cover should not affect DNR's general management approach to these areas. In addition, long-term forest cover designated outside current northern spotted owl conservation areas, for example in the Straits and South Coast planning units, will provide additional blocks of potential northern spotted owl habitat.

Inclusion of northern spotted owl habitat in long-term forest cover will not have a negative effect on northern spotted owls. Stands that provide habitat will continue to do so. Likewise, stands that do not yet provide northern spotted owl habitat will naturally develop toward habitat conditions, providing benefits to the northern spotted owl.

Silvicultural treatments in designated northern spotted owl conservation areas and landscapes within the OESF HCP Planning Unit will continue according to HCP conservation strategies, except where special habitat areas overlap these areas under Alternatives C, D, E, and G. Areas of overlap cannot be thinned because commercial thinning and regeneration harvests are not allowed in special habitat areas under these alternatives. Thinning is allowed in non-marbled murrelet habitat in special habitat areas under Alternative H, as long as thinning remains consistent with the northern spotted owl conservation strategy in the 1997 HCP.

[6] Low-quality northern spotted owl habitat is the same as Young Forest Habitat in the OESF.

Table 4.5.2. Summary of Potential Impacts to Wildlife

Key questions	Criteria	Measures	Potential impacts
Could 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 long-term forest cover. 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 could occur due to 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 long-term forest cover 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 habitat and population.

Analysis Questions

- *How do the alternatives affect marbled murrelet habitat, how are changes to habitat quantity and quality expected to affect the marbled murrelet population, and how do the alternatives increase or reduce risk to murrelet populations?*
- *Do the alternatives provide habitat distribution in high value landscapes for marbled murrelet conservation? These high-value landscapes include the following strategic locations: Southwest Washington, the OESF and Straits (west of the Elwha River), and North Puget.*

Evaluation Criteria

As described in Section 3.6, both the marine and inland habitats[7] of the marbled murrelet play key roles in the life cycle of the species. The proposal involves management activities on forested DNR-managed lands, not the marine environment, and therefore this analysis does not address impacts to the marine environment. This analysis will focus on how inland habitat is affected by the alternatives and how anticipated changes to that habitat will impact the marbled murrelet population in Washington.

Scale of Analysis

This analysis considers all DNR-managed lands within the analysis area, with data summarized by landscape and strategic location (refer to Section 2.3) when important for comparisons among the alternatives. Comparative inland habitat and population data from other conservation zones (refer to Section 3.6) also is considered in order to understand relative impacts of the alternatives.

How Impacts Are Measured

The analysis considers:

- Inland habitat quantity, including anticipated loss and gains of habitat through the life of the 1997 HCP
- Inland habitat quality, including P-stage and edge effects
- Disturbance impacts to inland habitat from forest use and management activities

[7] Inland habitat means marbled murrelet habitat on land, in other words nesting habitat. The term “inland habitat” is used in this section and in Section 3.6 of this RDEIS to distinguish inland habitat from marine habitat.

- Amount and quality of inland habitat in strategic locations, which are geographically important areas to the murrelet
- Relative impacts of each alternative to the marbled murrelet population in Washington using a population viability analysis model that considers two future scenarios for marbled murrelet demography

Summary of Direct, Indirect, and Cumulative Impacts

DNR's forest management activities cause both direct and indirect impacts to marbled murrelets. Direct impacts in this analysis are those that result from both short-term and long-term changes to inland habitat from implementation of each alternative. For the purposes of this analysis, indirect impacts are associated with non-harvest activities such as recreation, road management, and special uses.

Timber harvesting can result in both direct and indirect effects to murrelets. These effects can include the direct loss and fragmentation of habitat, increased risk of nest predation near harvest edges, habitat degradation associated with harvest edges, disruption of nesting behaviors associated with noise and visual disturbance, and the potential for direct mortality of murrelet eggs or chicks if an active nest tree is felled (USFWS 1997). Loss of inland habitat was the primary reason for the listing of the murrelet as a threatened species in 1992, and habitat loss continues to be an important stressor affecting murrelet trends (Raphael and others 2016). The amount and distribution of inland habitat is the strongest indicator associated with the distribution and trends of murrelets at sea. Areas with greatest inland habitat loss correspond directly to areas of the greatest declines in murrelet numbers at sea. Over the past 15 years, both the loss of inland habitat and declines in murrelet numbers have been highest in Washington compared to Oregon and California (Raphael et al. 2016).

Loss of inland habitat reduces nest site availability and displaces murrelets that have nesting fidelity to the harvested area. The effects of displacement due to habitat loss include nest site abandonment, delayed breeding, failure to initiate breeding in subsequent years, and failed breeding due to increased predation risk at marginal nesting sites. Each of these outcomes has the potential to reduce the nesting success for individual breeding pairs, and ultimately could result in the reduced recruitment of juvenile birds into the local population (Raphael and others 2002). The best available information regarding murrelet responses to inland habitat loss indicate that individual murrelets directly affected by habitat removal are essentially removed from the breeding population due to displacement and predation effects, although these effects may take several years to manifest (Raphael and others 2002).

The alternatives propose to conserve inland habitat and recruit new habitat in existing conserved forestlands and in designated murrelet-specific conservation areas, which will result in new and higher-quality habitat developing over time. DNR will harvest habitat in other areas.

This section compares the relative impacts of the action alternatives and how these impacts ultimately affect the marbled murrelet population associated with DNR-managed lands.

Direct Impacts: Habitat Loss and Gain

Ongoing forest management within the analysis area will result in short-term losses of mostly low-quality inland habitat under all alternatives except alternatives F, G and H, and long-term gains of both low- and high-quality habitat within long-term forest cover.

PROTECTION OF OCCUPIED SITES

All of the alternatives protect occupied sites, which are habitat patches of varying size in which murrelets are assumed to nest based on field observations. Alternatives B through H use occupied sites that were identified through HCP survey work and expanded by the Science Team Report (adding approximately 16,000 acres as compared to the no action alternative). Timber harvest would be prohibited in these areas, as would most of the forest management and land use activities that remove inland habitat. In isolated cases, limited forest management activities may occur within an occupied site, such as a road construction or individual tree removal. All action alternatives except Alternative B include 164- or 328-foot (50- or 100-meter) buffers on occupied sites. Alternatives C through H use special habitat areas, emphasis areas, or MMMAs that further increase the security forest[8] 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	Alt. G	Alt. H
Increases acres of occupied sites compared to current practice	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Applies occupied site buffers	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Includes additional security forest acres for selected occupied sites	No	No	Yes—special habitat areas and emphasis areas	Yes—special habitat areas	Yes—special habitat areas and emphasis areas	Yes—MMMAs	Yes—special habitat areas and emphasis areas and MMMAs	Yes—special habitat areas
Applies conservation measures[b] to protect occupied sites from disturbance	No[a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[a] The interim strategy does require timing restrictions for some forest management activities near occupied sites.

[b] Refer to Chapter 2 for conservation measures.

[8] A closed-canopy forest stand over 80-feet tall that is located adjacent to marbled murrelet habitat and provides security from windthrow, predation, and other disturbances.

The use of buffers and other protective measures on occupied sites reduces the risk to inland 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 benefits marbled murrelets in many ways, including potentially reducing predation and thus increasing productivity, reducing the potential for habitat to be lost to natural disturbance over time, and likely reducing the risk of birds having to change nest locations.

HABITAT LOSS FROM HARVEST

Outside of long-term forest cover, habitat for the marbled murrelet will be released for harvest under all alternatives. Although this habitat will be available for harvest, it is not known if it will be harvested. DNR's sustainable harvest calculation forest estate model (DNR 2016) will determine the actual amount of habitat proposed for harvest. In order to evaluate a "reasonable worst case" scenario, the analysis assumes that all of this habitat will be harvested and that harvest of this habitat will occur in the first decade of the planning period for all alternatives. Under DNR's preferred alternative, Alternative H, harvest of 3,600 adjusted acres (approximately 11,000 raw acres) of marbled murrelet habitat that DNR otherwise would be authorized to harvest upon amendment of its incidental take permit would be delayed (metered) until the end of the first decade following implementation. Metering will maintain habitat capacity while additional habitat is developed under the long-term conservation strategy. These metered acres will become available for harvest at the beginning of the second decade.

For analysis, inland habitat is described as either low quality (P-stage value 0.25 to 0.36) or high quality (P-stage value 0.47 to 0.89). Table 4.6.2 estimates the acres of low-quality and high-quality habitat that will be released for harvest in the first decade outside of long-term forest cover.

The potential exists for new road construction to occur in occupied sites, occupied site buffers, and marbled murrelet conservation areas under all alternatives (refer to Table 2.2.6). Under Alternatives B, E, and F, new road construction would be allowed in these areas following consultation with USFWS but would be avoided if possible. Under Alternative H, new road construction would be allowed only when no other route is feasible (if in marbled murrelet habitat, DNR will consult with USFWS to minimize impacts). Under Alternatives C, D, and G, new road construction would only be allowed in these areas if required by state or federal law or emergency. The amount of new road construction through occupied sites, occupied site buffers, or special habitat areas is unknown but is expected to be minimal because DNR will avoid these areas when possible.

Table 4.6.2. Estimated Acres of Habitat (Raw Acres) Released for Harvest in the Analysis Area by the End of the Analysis Period

		Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Low-quality habitat loss to harvest (P-stage value 0.25–0.36)	Southwest Washington strategic location	4,241	7,844	4,459	4,458	4,458	1,769	2,443	5,068
	OESF and Straits (West of the Elwha River) strategic location	7,167	9,166	7,370	7,901	6,685	3,934	1,054	6,884
	North Puget strategic location	13,009	13,304	12,009	12,033	11,675	7,751	11,092	11,550
	Other high value landscape	7,115	9,187	8,864	8,865	8,871	5,669	8,866	8,845
	Marginal landscape	1,082	1,715	1,715	1,715	1,715	1,711	1,715	1,715
Subtotal		32,614	41,216	34,417	34,972	33,404	20,834	25,170	34,062
High-quality habitat loss to harvest (P-stage value 0.47–0.89)	Southwest Washington strategic location	7	259	0	175	0	76	0	174
	OESF and Straits (West of the Elwha River) strategic location	739	1,593	0	1,319	0	468	0	1,139
	North Puget strategic location	2,523	2,568	0	2,353	0	1,403	0	1,553
	Other high value landscape	1,082	1,542	0	1,442	0	881	0	1,238
	Marginal landscape	97	97	0	97	0	93	0	97
Subtotal		4,448	6,059	0	5,386	0	2,921	0	4,201
Total acres		**37,063**	**47,272**	**34,417**	**40,357**	**33,404**	**23,754**	**25,170**	**38,264**

Most harvest of inland habitat outside of long-term forest cover in the first decade is expected to be in low-quality habitat. Of the total habitat released for harvest under each alternative, 87 to 100 percent is low quality. The most habitat released for harvest overall is under Alternative B, followed by Alternatives

D, H, A, C, E, G, and F. In order of most to least high-quality habitat released for harvest are alternatives B, D, A, H, and F. Alternatives C, E and G included rules that prohibit the release of high-quality habitat. Alternatives F and G release fewer acres than Alternative A, the no action alternative.

As explained previously, Alternative H meters 3,600 adjusted acres of habitat (approximately 11,000 raw acres) during the first decade after implementation. In Southwest Washington, Alternative H releases approximately 800 more acres of low-quality habitat and approximately 200 more acres of high-quality habitat than Alternative A. For all landscapes combined, Alternative H releases less high-quality habitat than Alternatives A, B, and D and releases less low- and high-quality habitat combined than Alternatives B and D.

HABITAT GAINS

Throughout long-term forest cover for all alternatives, inland 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 1997 HCP, initial habitat loss outside long-term forest cover will be outpaced by gains in habitat within long-term forest cover, in which forest cover will be maintained through the current regulatory framework. Gains are expected under every alternative (refer to Table 4.6.3 and Figure 4.6.1). Alternatives C through H provide more low-quality habitat in the final decade of the planning period than Alternative A in two of the strategic locations, Southwest Washington and North Puget. Alternatives C through H also provide more high-quality habitat in the final decade of the planning period than under Alternative A in all three strategic locations, Southwest Washington, OESF and Straits (west of the Elwha River), and North Puget.

Table 4.6.3 Estimated Acres of Habitat in the Final Decade of the Planning Period in Long-Term Forest Cover, by Landscape or Strategic Location and Alternative

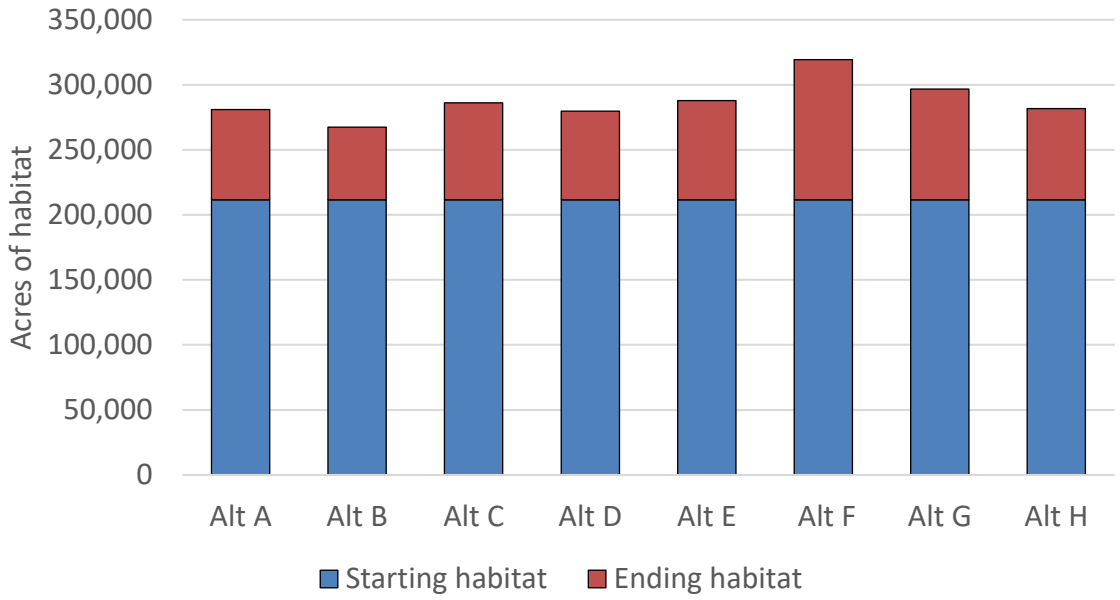
	Landscape	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Final decade potential low-quality habitat	Southwest Washington strategic location	11,291	11,140	11,706	11,706	11,706	12,202	11,738	11,593
	OESF and Straits west of the Elwha River strategic location	5,034	3,578	4,047	4,446	4,471	4,599	4,424	4,285
	North Puget strategic location	21,623	21,341	22,420	22,625	22,853	30,061	22,969	22,265
	Other high value landscape	41,319	37,531	38,343	38,341	38,335	47,112	38,329	38,313
	Marginal landscape	22,564	22,234	22,234	22,234	22,234	22,239	22,234	22,234
Total low-quality habitat		101,831	95,824	98,750	99,352	99,599	116,213	99,694	98,690
Final decade potential high-quality habitat	Southwest Washington strategic location	26,140	22,371	28,125	27,390	28,126	31,537	30,592	26,980
	OESF and Straits (west of the Elwha River) strategic location	69,764	67,836	71,594	69,570	72,373	76,001	77,278	71,016
	North Puget strategic location	49,505	49,092	53,420	50,716	53,575	58,185	54,980	52,040
	Other high value landscape	30,307	29,433	31,264	29,803	31,253	34,528	31,259	30,024
	Marginal landscape	3,397	2,878	2,978	2,878	2,978	2,882	2,978	2,878
Total high-quality habitat		179,113	171,610	187,381	180,357	188,305	203,133	197,087	182,938
Combined totals		**280,945**	**267,434**	**286,130**	**279,708**	**287,906**	**319,347**	**296,783**	**281,627**

NET HABITAT BY END OF PLANNING PERIOD

If the proposed harvest of 24,000 to 47,000 acres (depending on alternative) of inland habitat outside long-term forest cover during the first decade for Alternatives A through H and the predicted habitat development in long-term forest cover during the 5-decade planning period are considered together, the result should be a net increase of raw habitat acreage for every alternative, including the no action alternative (Alternative A) (Refer to Figure 4.6.1).

Alternatives C, E, F, G and H result in more total inland habitat than Alternative A. Alternative C, E, F, G, and H will all have more total high-quality habitat than Alternative A. Alternatives B and D will result in less total habitat and less high-quality habitat than either Alternative A or the other action alternatives.

Figure 4.6.1. Growth of Habitat Through Time, by Alternative



Accounting for Habitat Quality

Although every alternative shows a net gain of habitat acres through the life of the 1997 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

In the calculation of impacts and mitigation in the analytical framework (refer to Appendix B), acres of inland habitat lost or gained are adjusted by their P-stage values, which reflects the quality of that habitat based on its probability of being used for murrelet nesting. 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 also is combined with other adjustment factors (refer to the following section).

INTERIOR FOREST HABITAT

Larger patches of habitat within interior forest ("interior forest habitat"), which is habitat 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 habitat is not subject to these edge effects. Chapter 2 provided summary data on the relative interior and edge conditions expected in long-term forest cover under each alternative. 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 landscapes and among landscapes. Development of habitat in areas of interior forest may be most important in terms of developing functional habitat for the marbled murrelet over time.

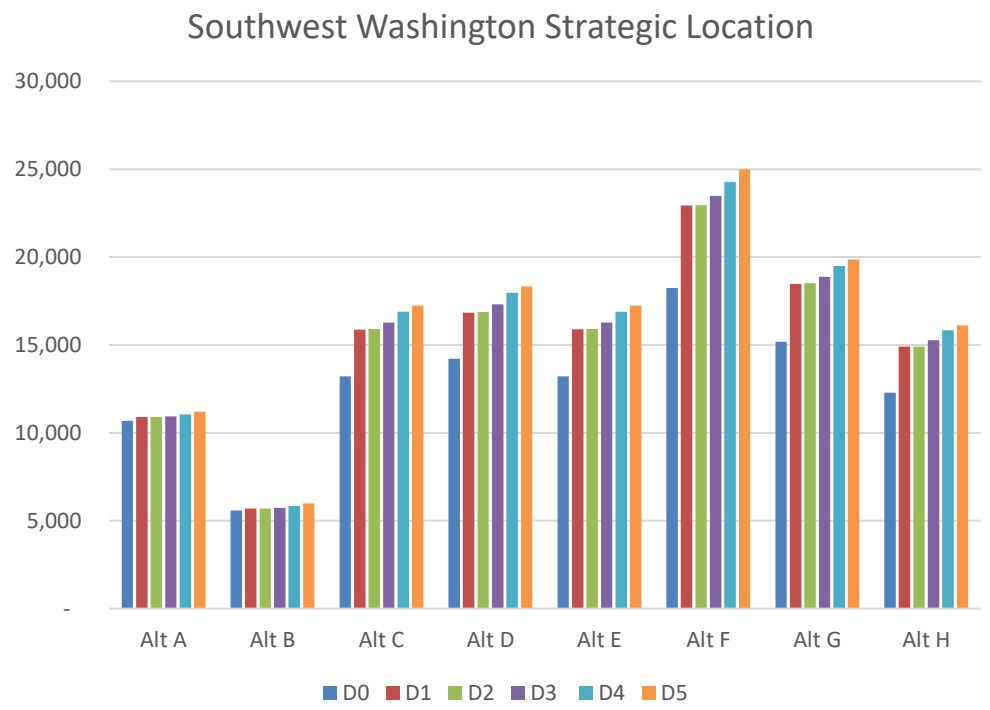
Alternatives A, F, G, and H apply 328-foot (100-meter) buffers around all occupied sites. Alternatives C, D, and E also apply 328-foot (100-meter) buffers around all occupied sites, except in the OESF HCP Planning Unit, in which occupied sites that are 200 acres in size or larger receive 164-foot (50-meter) buffers. These buffers effectively increase the area of interior forest habitat associated with occupied sites and minimize the potential for edge effects from future management in these sites. Table 4.6.4 shows the overall change in interior forest habitat and Figure 4.6.2 shows how interior forest habitat is expected to develop in each of the landscapes. Alternative B does not apply any buffers, so it is expected that occupied sites likely will degrade over time as predation and windthrow erode occupied sites. Some interior forest habitat will develop in other areas of long-term forest cover under Alternative B to partially offset losses to occupied sites.

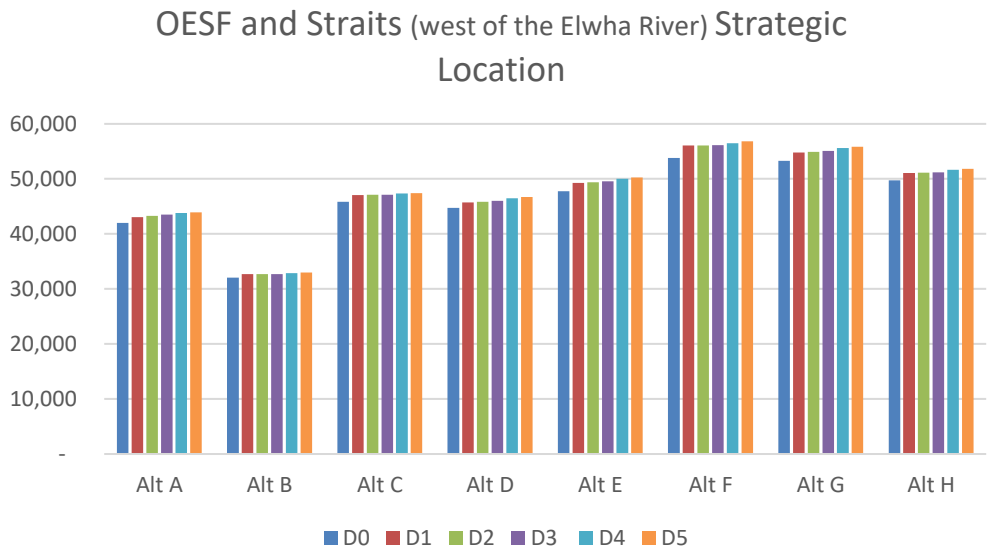
Table 4.6.4. Change in Raw Acres of Interior Forest Habitat Between Existing Conditions and Decade 5, by Alternative

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alt H
Existing conditions	84,536							
Decade 5	105,658	84,715	119,046	118,161	122,978	165,980	134,748	121,579

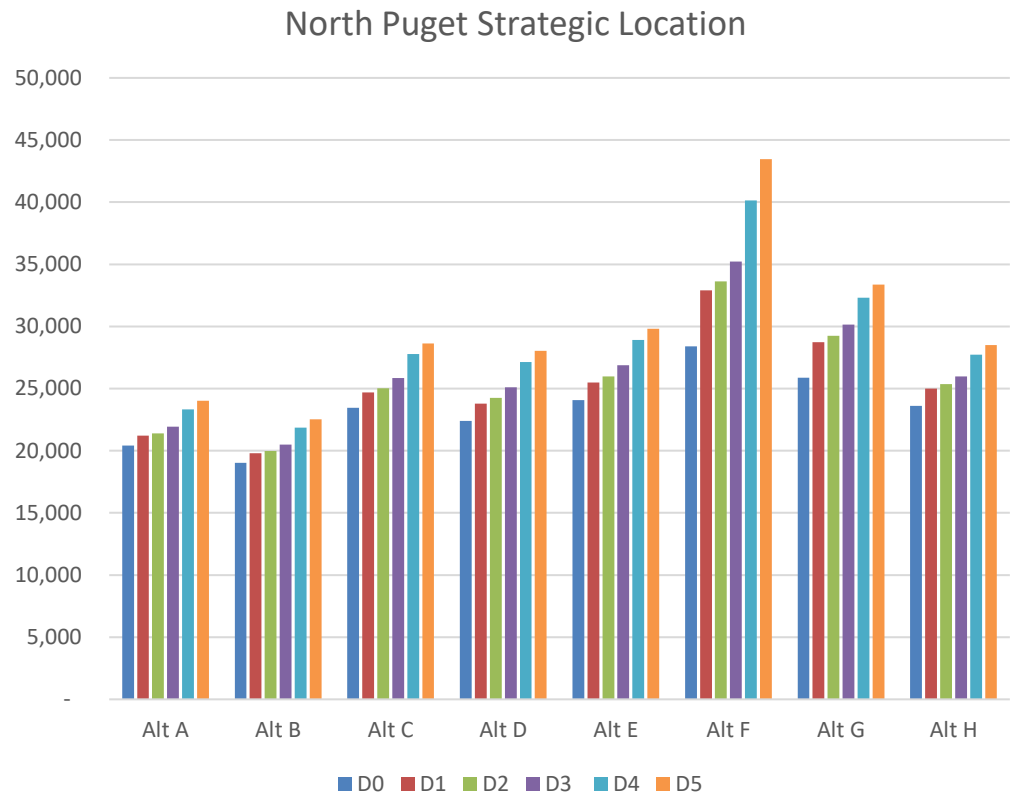
The total amount of interior forest habitat increases under all alternatives. Alternative H contains more interior forest habitat in decade five than Alternatives A, B, C, and D. Alternatives G and F contain more interior forest habitat in Decade 5 than Alternative H.

Figure 4.6.2. Estimated Growth of Interior Forest Habitat Among Landscapes[9]





[9] 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 occupied sites. Within the first two decades, growth of new habitat and development of higher-quality habitat outpaces this initial habitat loss.


North Puget Strategic Location
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
Alt A
Alt B
Alt C
Alt D
Alt E
Alt F
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D0
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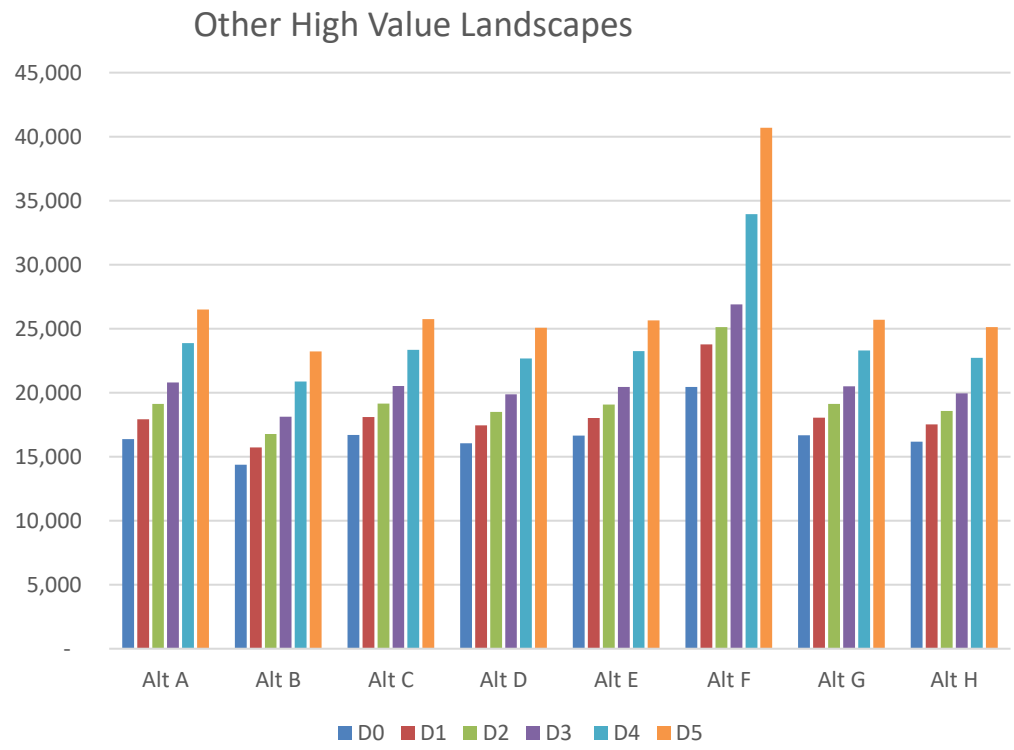
D2
D3
D4
D5


Other High Value Landscapes
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
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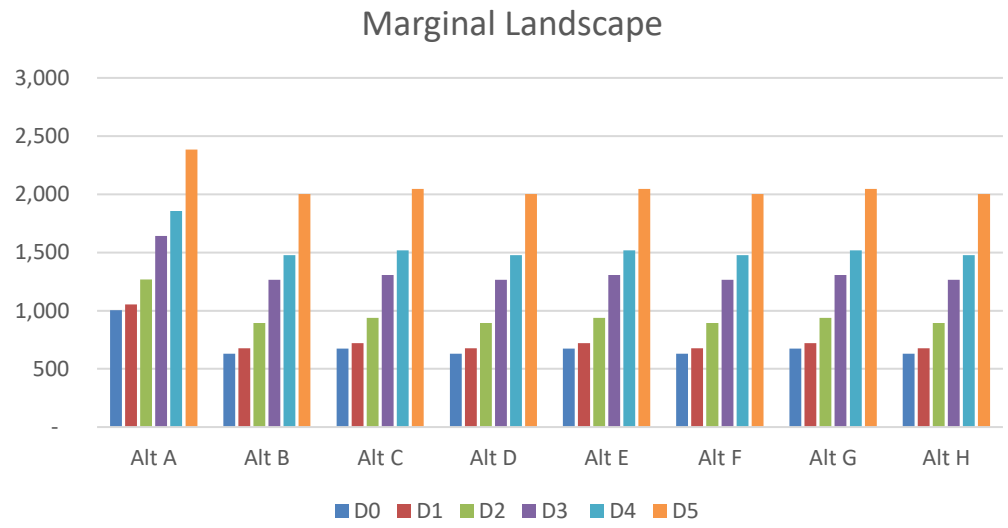


Compared to Alternative A, Alternatives C through H conserve more interior forest habitat in Southwest Washington, the OESF and Straits (west of the Elwha River), and North Puget landscapes because these alternatives incorporate marbled murrelet conservation areas in addition to existing occupied sites. Alternative B conserves less interior forest habitat than Alternative A in these landscapes. In the other high value and marginal landscapes, which are lower priority areas for conservation, the results are different. In the other high value landscapes, only Alternative F conserves more interior forest habitat than Alternative A. In the marginal landscape, all action alternatives conserve less interior forest habitat than Alternative A. Overall, Alternatives C through H reduce edge effects on murrelet habitat by strategically configuring some areas of long-term forest cover in different ways, which results in a somewhat greater proportion of interior forest habitat than Alternative A, the no action alternative.

Increases in interior forest habitat are expected to benefit marbled murrelet by reducing edge effects and predation and therefore may increase nest success and population numbers over time.

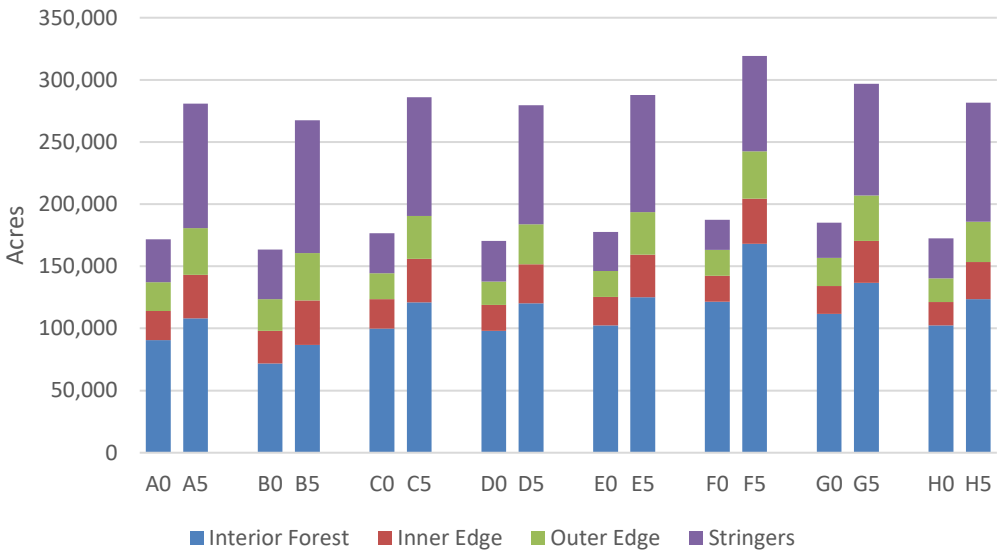
EDGE EFFECTS

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 differ 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 conditions versus projected edge conditions for all alternatives at the end of the planning period (Decade 5). Stringer habitat also is presented (refer to Figure 4.6.3).

Figure 4.6.3. Current and Ending (Decade 5) Habitat, by Alternative and Edge Position

In the horizontal axis, numbers indicate the decade. For example, A0 means Alternative A, Decade 0.



Under all alternatives, existing edges within long-term forest cover soften and disappear over time as younger forests within long-term forest cover mature. Limitations on timber harvest and related activities (such as road construction) mean that the creation of new edges in habitat also will diminish significantly through time in long-term forest cover under all alternatives. Under all alternatives except Alternative B, occupied sites are buffered and existing edges will soften and disappear as forests within the buffers mature. Under Alternative B, forests surrounding occupied sites will be subject to harvest resulting in hard edges, therefore increasing the amount of edge. Reduction in edge is expected to benefit marbled murrelets by reducing the potential for edge effects and predation, potentially increasing nest success and population numbers over time. Increases in edge are likely to decrease the nesting success of murrelets within occupied sites, as well as eroding the amount of habitat over time due to increased windthrow.

Roads

While existing forest edges in long-term forest cover will soften and abate over time as forests mature, many roads through long-term forest cover 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 long-term forest cover. 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 that caused by adjacent harvested and replanted stands. About 5 percent of habitat is estimated to be affected by road edges throughout the planning period.

Stringers

All alternatives also project a relatively high amount of habitat in a stringer condition. These habitat stringers are primarily managed for riparian conservation and will never develop interior forest habitat because of their configuration. Habitat in stringers may provide some isolated nesting opportunities,

likely with reduced nest success rates. Thinning of habitat in stringers, and all other long-term forest cover areas, is not allowed under any alternative to protect marbled murrelets that may be using these areas. For the purposes of calculating mitigation and the effects of each alternative on marbled murrelet, stringers are assumed to have no value as habitat.

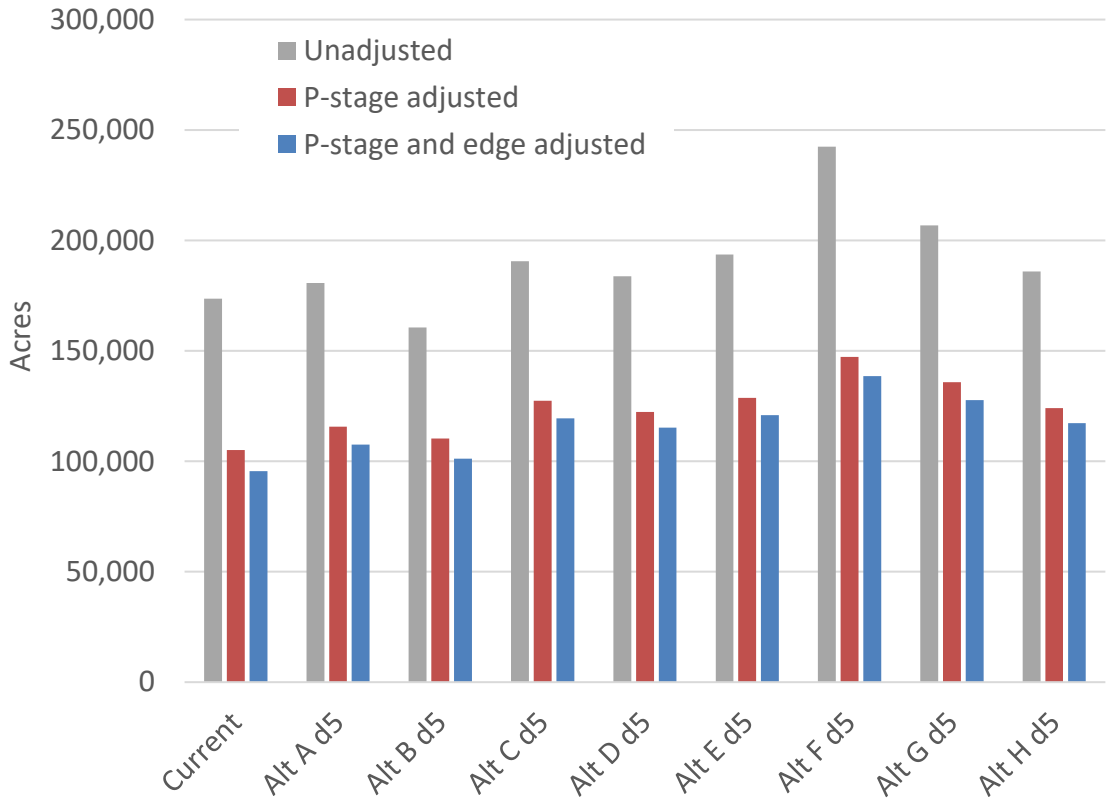
HOW P-STAGE AND EDGE INFLUENCE HABITAT QUALITY

Figure 4.6.4 compares the influence of P-stage to the influence of edge effects. In this graphic, acres of inland habitat (excluding stringers) are adjusted for P-stage alone (by multiplying the habitat acreage by its P-stage value, shown in red) and for both P-stage and edge condition (shown in blue). In Decade 5, the average acreage adjusted for P-stage alone is 65 percent of the average, unadjusted habitat acreage, while the average acreage adjusted for both P-stage and edge is 61 percent of the average, unadjusted habitat acreage (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 H. Alternative B is the only alternative that has less unadjusted, P-stage adjusted, and edge and P-stage adjusted habitat than Alternative A in Decade 5, although it does contain more P-stage adjusted, and edge and P-stage adjusted habitat than under current conditions at Decade 5.

Figure 4.6.4. Comparing the Influence of P-stage and Edge Effects: Current Murrelet Habitat Across all DNR-Managed Lands (Excluding Stringers) Compared With Estimated Future (Decade 5) Murrelet Habitat, by Alternative

In the horizontal axis, "d" means decade. For example, d5 means Decade 5.



HOW LOCATION INFLUENCES HABITAT QUALITY

As described in Chapter 2, Section 2.3 of this RDEIS, another factor influencing habitat quality among the alternatives is geographic location. To reflect this, the analysis area has been divided into landscapes: high-value landscapes, which includes both the strategic locations and other high-value landscapes; and marginal landscapes. The action alternatives place proportionately less inland habitat conservation in the marginal landscapes, where distance from high-quality marine habitat, lack of occupied sites, and extensive anthropogenic development limits the marbled murrelet conservation potential of state trust lands. Conversely, proportionately more conservation is proposed for strategic locations (Southwest Washington, OESF and Straits (west of the Elwha River), and North Puget) within the high-value landscapes, where the highest levels of marbled murrelet use of state trust lands occur and where inland habitat is in close proximity to marine foraging areas. For example, some areas of the OESF are in close proximity to important marine foraging areas such as the Strait of Juan de Fuca and Pacific Ocean. Intermediate amounts of conservation occur in the other high-value landscapes, with emphasis on conservation in areas closest to marine waters. Within all of these high-value landscapes, habitat value is determined only by those factors already described, P-stage and edge effects.

Within the marginal landscapes, habitat value is reduced to 25 percent of its value based on P-stage and edge effects. Regardless of alternative, approximately 8 and 9 percent of inland habitat is expected to be located within the marginal landscape in the South Coast and South Puget HCP planning units, respectively, by Decade 5.

TIMING OF HABITAT LOSS AND DEVELOPMENT

Inland habitat that exists today currently provides nesting opportunities for murrelets and is therefore more valuable than habitat that will develop in the future (as forests mature). If inland habitat is impacted today, the offsetting mitigation (habitat of the same value 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 through the life of the 1997 HCP.

The decadal adjustment factor is based on how much inland habitat develops in a particular decade, as well as the decade in which that habitat is realized. For example, the total inland 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 inland habitat that develops between the first and second decades receives only 80 percent of the total credit because the habitat that grows during this decade will contribute to murrelet conservation for less time in four out of the five total decades (80 percent of decades). Growth occurring between the second and third decades receives 60 percent credit (three out of five decades of growth), and mitigation credits are calculated in this way through the end of the 1997 HCP (refer to Appendix I).

Putting it All Together: Quality of Habitat Gained and Lost Through Time

The overall losses and gains in inland 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. Inland habitat with little value (stringers) is excluded outright, and habitat in edge condition or located in the marginal landscape are assumed to have reduced quality.

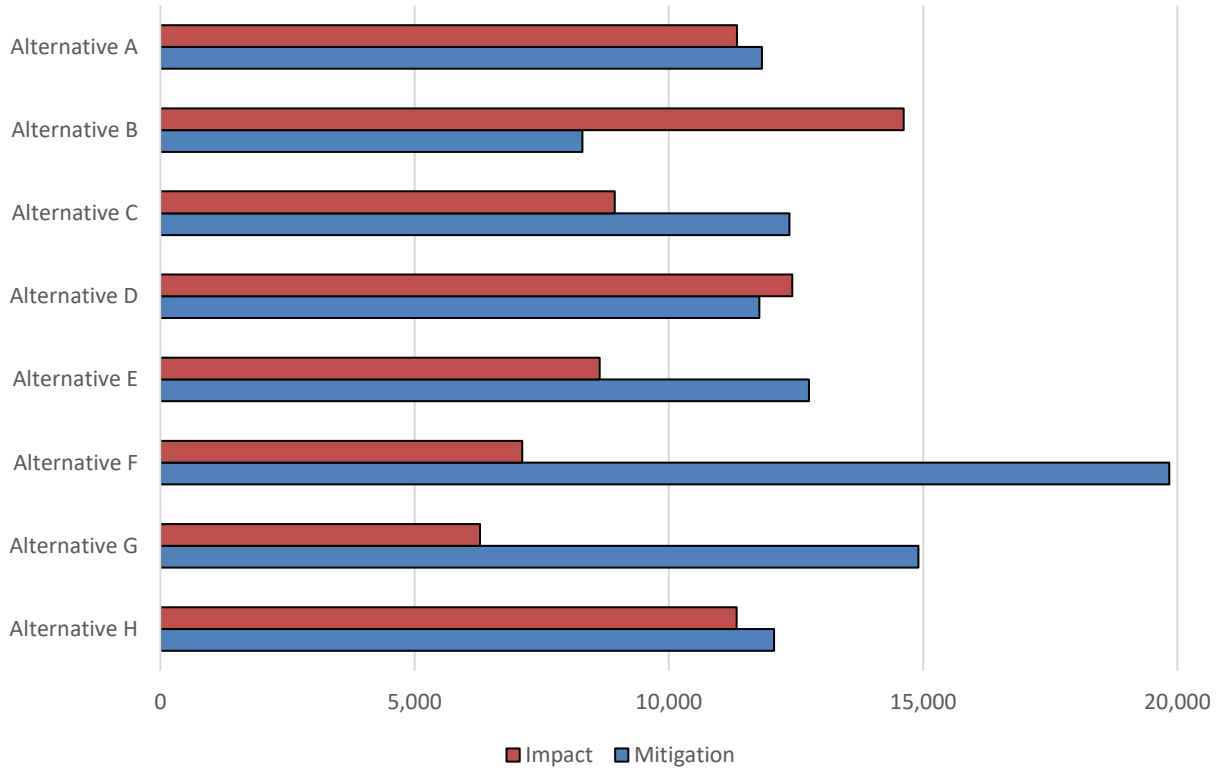
The result of these modifications can be reflected as a comparison of “impact” (habitat loss) to “mitigation” (habitat gain). As shown in Figure 4.6.5, Alternative F has the highest ratio of mitigation to impact at around 2.8:1. Alternatives C, E, and G show significantly more mitigation than impact over the planning period, while Alternatives A and H show only slightly more mitigation than impact. Alternatives B and D result in impact exceeding mitigation, with Alternative B having the greatest amount of impact compared to mitigation.

Under every action alternative, mitigation credit is assigned to inland habitat that currently exists or develops within long-term forest cover through the life of the 1997 HCP. Mitigation acres can be estimated and compared against potential impacts, which is the loss of inland habitat outside of long-term forest cover. Appendix H provides a detailed description of how DNR and USFWS (the Joint Agencies) estimated potential impact and mitigation acres under the proposed action.

It is important to recognize that while specific outcomes are presented, there are uncertainties associated with these estimates of impact and mitigation acres. These uncertainties include the following: habitat selection by marbled murrelets is complex and poorly understood, and forest growth and future habitat development may be influenced by many factors (such as climate change or natural disturbance) as described in Appendix E. These projections of future habitat development 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 tools are useful for understanding relative impact and mitigation for the different alternatives. The population viability model also is relevant for further interpretation of potential impacts. Refer to Figure 4.6.5 for a summary of impacts (for example, mostly habitat loss) and mitigation acres (habitat development over time) as measured by adjusted acres expected under each alternative.

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 landscapes. Table 4.6.5 shows the net acres in each strategic location when adjustments are made for habitat quality (P-stage, edge effects, and time).

Table 4.6.5. Acres of Mitigation Minus Impact, by Landscape or Strategic Location and Alternative

	Mitigation minus impact[a] (quality and time adjusted acres)							
Landscape or strategic location	**Alt. A**	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**	**Alt. F**	**Alt. G**	**Alt. H**
Southwest Washington strategic location	2,995	1,268	2,590	2,397	2,571	3,414	2,560	751
OESF and Straits west of the Elwha strategic location	1,356	-1,567	735	-399	1,303	2,722	3,742	434
North Puget strategic location	-2,878	-3,113	-177	-1,938	54	2,663	927	-1,072
Other high value landscapes	-1,047	-2,910	181	-706	178	3,935	1,388	627
Marginal landscape	62	-3	10	-5	10	-8	9	-5
Total (net)	488	-6,325	3,339	-651	4,116	12,726	8,626	735

[a] Positive values occur when mitigation exceeds impact, negative values when impact exceeds mitigation.

Changes in acres are strongly related to the condition of these landscapes 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 landscapes that begin with a relatively high proportion of protected, high-quality habitat (including OESF and Straits [west of the Elwha River]), negative acres can result for alternatives that shift the conservation focus from these areas to other locations. Southwest Washington, where conserved high-quality habitat is currently scarce, show gains in habitat under all the alternatives.

Although impact exceeds mitigation in the North Puget strategic location under Alternatives C, D and H, the difference is less than under Alternative A, the no action alternative, and overall mitigation exceeds impacts under Alternatives C, E, F, G, and H. In addition, mitigation exceeds impacts in the Southwest Washington and OESF and Straits (west of the Elwha River) strategic locations under Alternatives C, E, F, G, and H.

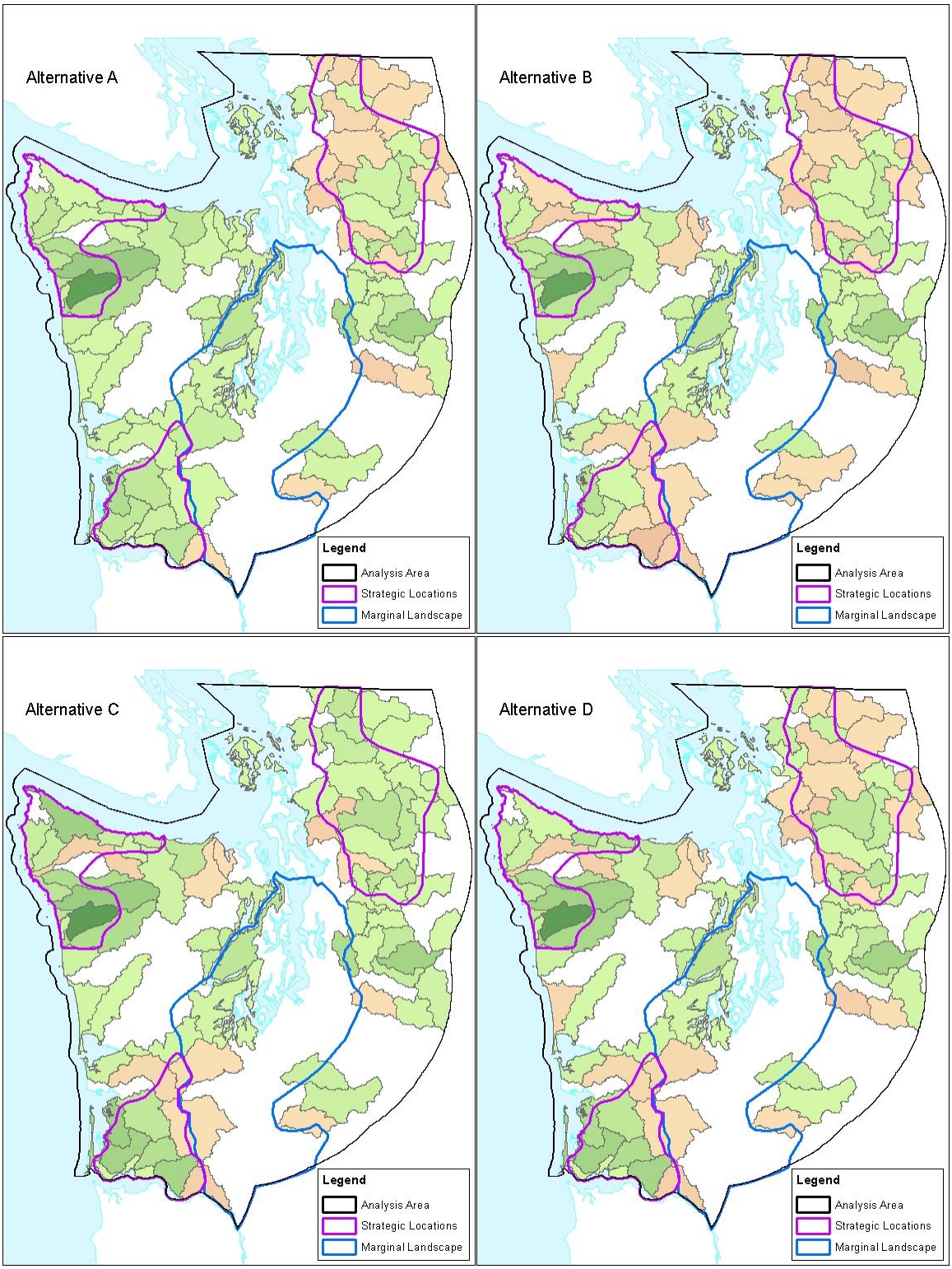
Habitat Distribution

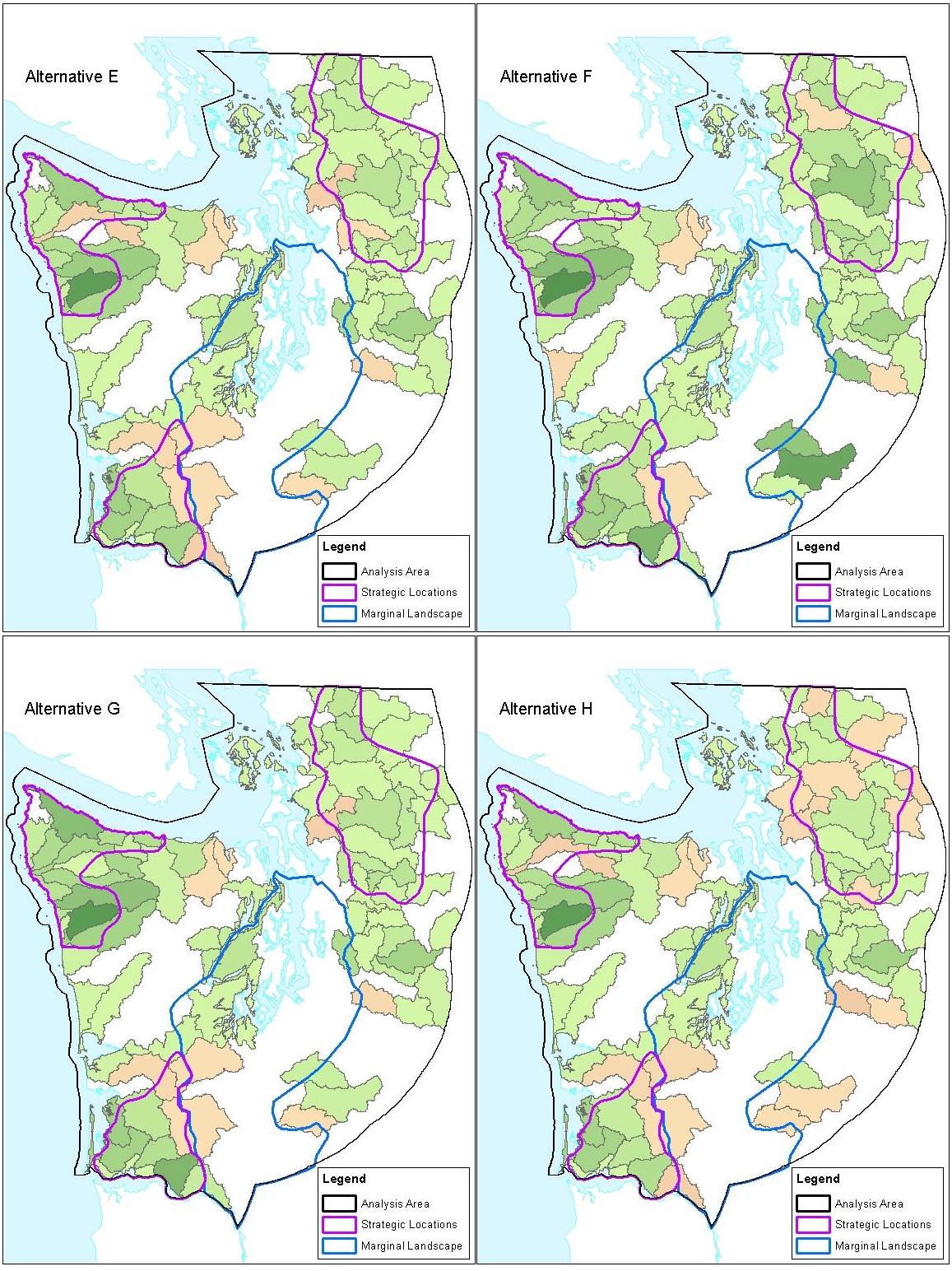
DNR conducted a distribution analysis comparing current and future habitat for each action alternative. The distribution analysis evaluates the change in acres of inland habitat (adjusted for P-stage and edge) from current conditions to the end (Decade 5) of the analysis period. Refer to Appendix H for a description of adjusted acres.

Habitat Location

As described in Chapter 3 of this RDEIS, an analysis was conducted to determine how inland habitat is distributed across the landscapes at a watershed scale. Under all alternatives, the adjusted acres of inland habitat increase in more watersheds than they decrease by Decade 5. Under alternatives C through H, more watersheds increase in adjusted acres and fewer decreased in adjusted acres than under Alternative A. Conversely, under Alternative B, fewer watersheds increase in adjusted acres and more watersheds decrease in adjusted acres than under Alternative A. Alternative B negatively affects distribution due to the decline of habitat in the northern half of the North Puget strategic location. Alternatives C through H improve the distribution of habitat compared to Alternative A. These alternatives result in a larger increase in adjusted acres in the strategic locations than Alternative A (Figure 4.6.6). In Figure 4.6.6, adjusted acres increase from current conditions in watersheds shown in green and decease from current conditions in watersheds shown in tan. Darker colors show larger changes (only watersheds containing at least 50 adjusted acres in Decade 5 are shown).

Figure 4.6.6. Change in Adjusted Acres by Watershed Between Current Conditions and Decade 5, by Alternative




Alternative E
Legend
Analysis Area
Strategic Locations
Marginal Landscape
Alternative F
Legend
Analysis Area
Strategic Locations
Marginal Landscape
Alternative G
Legend
Analysis Area
Strategic Locations
Marginal Landscape
Alternative H
Legend
Analysis Area
Strategic Locations
Marginal Landscape

Proximity to Occupied Sites

Research has shown that marbled murrelets are less likely to occupy inland habitat if it is more than 3.1 miles (5 kilometers) from existing occupied sites (Meyers and others 2002). Under Alternatives C through H, the area of inland habitat conserved within 3.1 miles (5 kilometers) of occupied sites increases as compared to Alternative A. Under Alternative B the area decreases (Table 4.6.6).

Table 4.6.6. Acres of Habitat at Decade 0 and Decade 5 in Long-Term Forest Cover Within 3.1 miles (5 Kilometers) of an Existing Occupied Site

	Alt A.	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Decade 0	130,000	124,000	135,000	130,000	135,000	141,000	142,000	132,000
Decade 5	178,000	167,000	183,000	178,000	184,000	199,000	192,000	180,000

USFWS designates critical habitat based on primary constituent elements (USFWS 2015). One element for inland habitat is forested areas within 0.5 mile (0.8 kilometers) of potential nest trees that have a canopy height of at least half the site potential tree height. While potential nest trees are present throughout habitat on DNR-managed lands, occupied sites represent locations of known nesting behavior. Under Alternatives C through H, the area of habitat conserved within 0.5 mile of occupied sites increases, as compared to Alternative A. Under Alternative B, the area decreases (Table 4.6.7).

Table 4.6.7. Current and Ending (Decade 5) Habitat in Long-Term Forest Cover Within 0.5 mile (.8 km) of an Existing Occupied Site

	Alt A.	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Decade 0	80,000	78,000	83,000	83,000	84,000	84,000	85,000	83,000
Decade 5	94,000	87,000	96,000	96,000	97,000	98,000	99,000	95,000

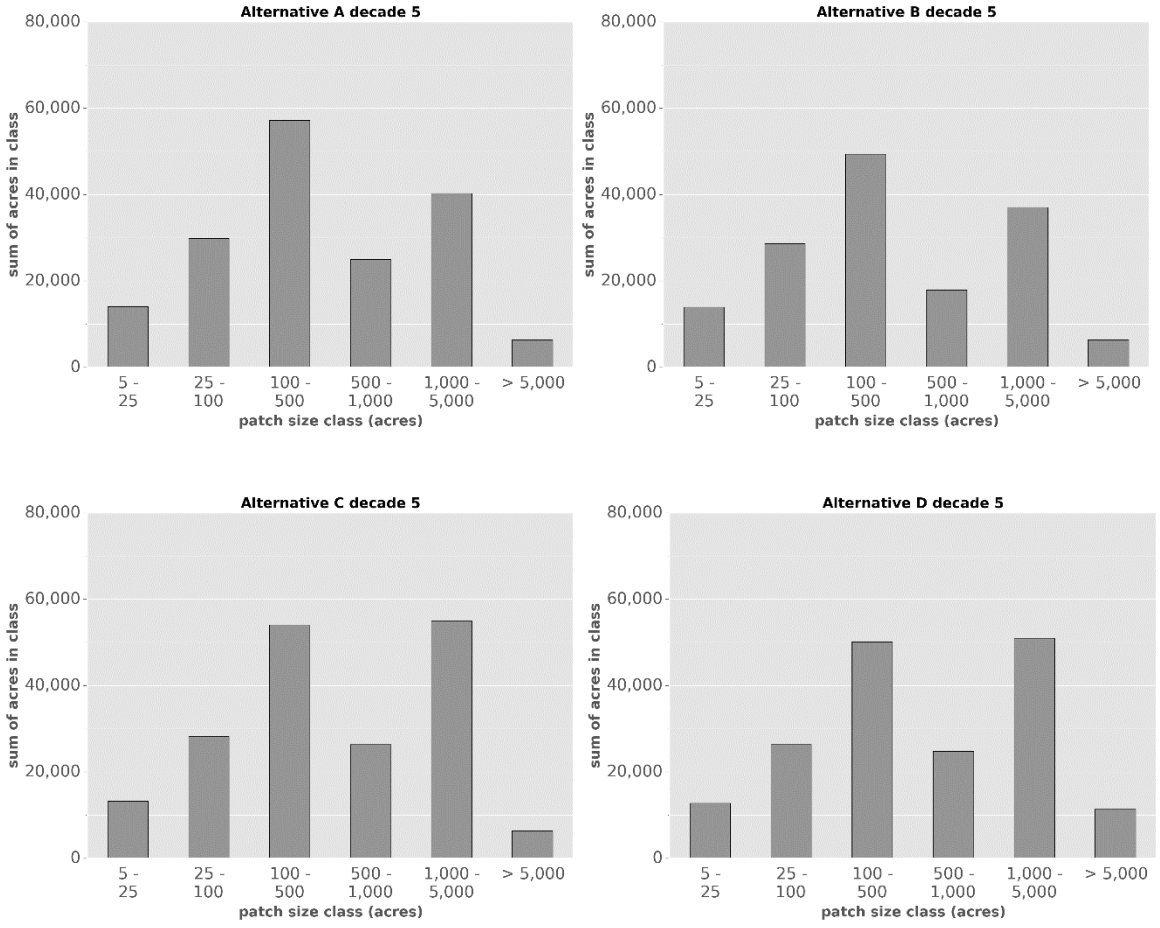
Habitat Patch Size

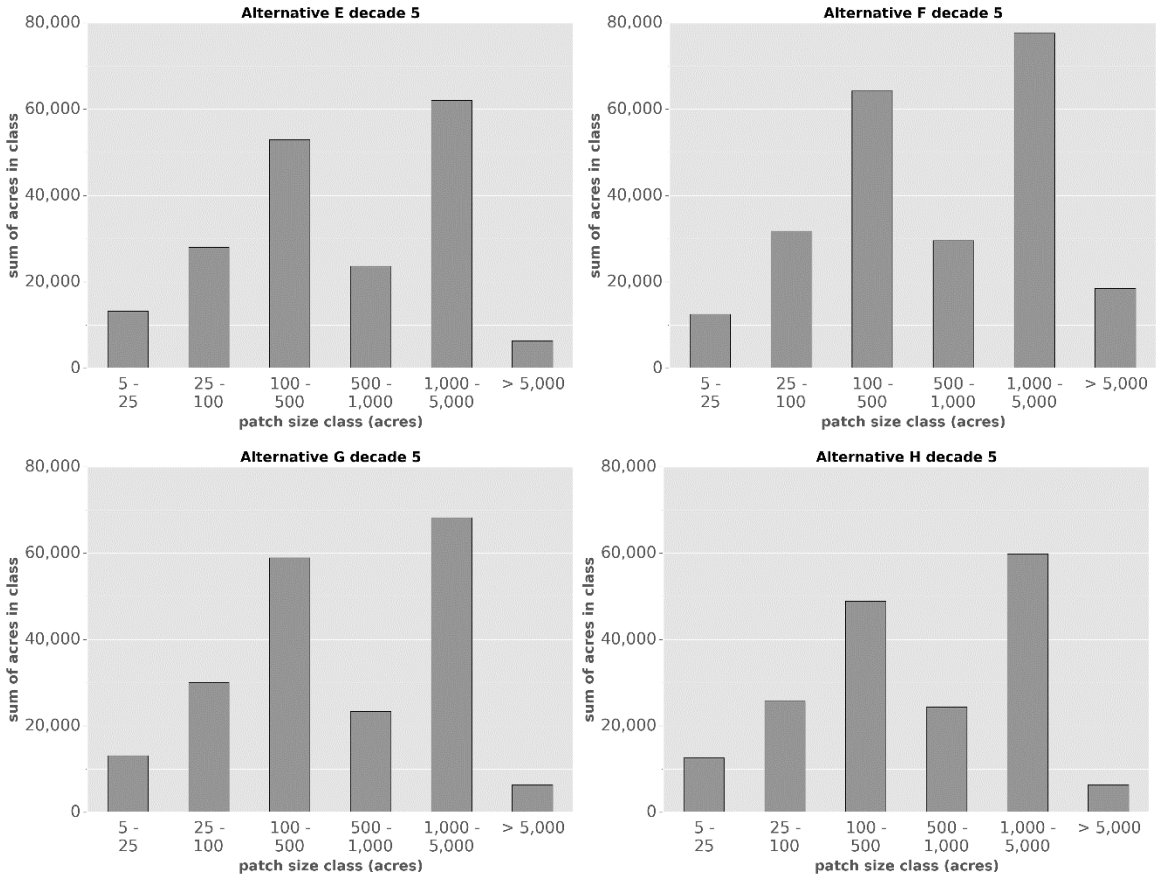
As inland habitat develops under each alternative, the number of habitat patches five acres or larger will increase, as will the total area of habitat in these patches (Table 4.6.8). Differences between the alternatives are most apparent for habitat patches equal to or larger than 1,000 acres. More habitat patches and more area in habitat patches will benefit marbled murrelet by providing more potential nesting sites and reducing edge effects compared to current conditions. Compared to Alternative A, Alternatives C through H increase the number of acres in patches greater than or equal to five acres and the number of acres in patches greater than or equal to 1,000 acres. Under Alternative B, the number of acres in both patch size categories decreases (Table 4.6.8 and Figure 4.6.7) (for current size distribution of habitat patches, refer to Table 3.6.3).

Table 4.6.8. Ending (Decade 5) Habitat Patches

	Alt A.	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
# patches ≥ 5 acres	2,025	1,950	1,925	1,846	1,911	1,996	1,966	1,817
Sum of area in patches ≥ 5 acres	180,000	160,000	190,000	183,000	193,00	242,000	207,000	185,000
# of large patches (≥ 1,000 acres)	23	21	29	29	32	44	35	31
Sum of area in large patches (≥ 1,000 acres)	54,000	50,000	68,000	69,000	75,000	103,000	82,000	73,000

Figure 4.6.7. Ending (Decade 5) Size Distribution of Habitat Patches



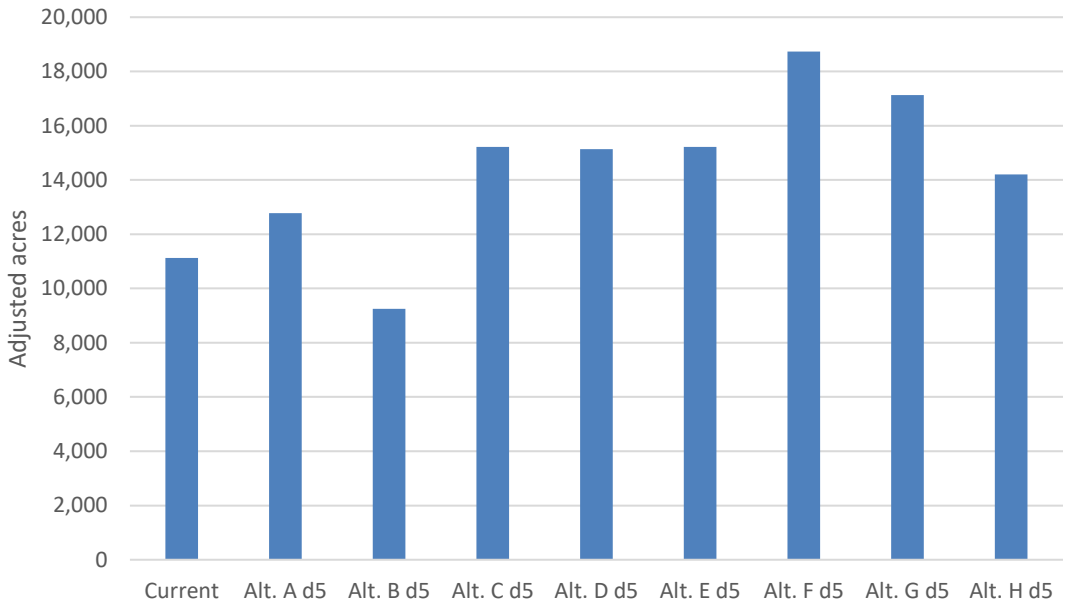


Alternatives C through H provide more area in patches greater than or equal to 1,000 acres than Alternative A. These large patches are expected to provide large areas of interior forest habitat, and so may benefit marbled murrelet reproduction.

Focus on Southwest Washington

USFWS 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 inland habitat and most known marbled murrelet occupied sites in southwest Washington are located on DNR-managed lands. The Southwest Washington strategic location covers this area. The Joint Agencies identified a range of conservation options for these lands to maintain and improve the distribution of inland habitat in this important area. The no action alternative would protect approximately 84 percent of all known habitat in this strategic location. Alternatives C, D and E would protect approximately 83 percent of the habitat, Alternatives F and G would protect 91 percent of the habitat, and Alternative H would protect 80 percent. Alternative F protects the most habitat, approximately 91 percent, while Alternative B protects the least, 70 percent (significantly less than the no action alternative). All alternatives, except Alternative B, result in an increase in habitat in interior forest condition and increase in habitat capacity as compared to Alternative A (Figure 4.6.8).

Figure 4.6.8. Current and Decade 5 Adjusted Acres of Inland Habitat in the Southwest Washington Strategic Location



Effect on Marbled Murrelet Populations

The analysis in this RDEIS measures the amount and quality of inland habitat harvested, conserved, and developed over the analysis period. However, the amount and timing of inland habitat conserved and developed may not directly translate to immediate murrelet population growth or decline. Uncertainties about marbled murrelet survival, reproduction rates, dispersal, and other environmental influences may affect how the population responds to increased inland habitat.

To help understand how marbled murrelet populations might respond to the variations in inland habitat under each alternative, the Joint Agencies engaged Dr. Zach Peery of the University of Wisconsin, an expert population ecologist and marbled murrelet biologist, and Gavin Jones, a Ph.D candidate in Dr. Peery's lab, to develop a population viability model that incorporates the analytical framework and habitat estimates. The model provides a comparison of how each alternative might perform as a long-term conservation strategy with respect to the marbled murrelet population in Washington. This model is not intended to provide an absolute estimate of population response for a

Text Box 4.6.1. What is New in the Population Viability Analysis for the RDEIS?

In this RDEIS, just as it was in the 2016 DEIS, a P-stage value of 1 indicates an occupied site. This value was assigned in the P-stage model to all acres within an occupied site, regardless of the forest condition of those acres. For example, some occupied sites may include areas of non-habitat.

For the population viability analysis in this RDEIS, Dr. Zach Peery and Gavin Jones modeled the actual P-stage value of all acres within occupied sites, instead of simply assigning the entire occupied site a value of 1. They also modeled the growth of forests in occupied sites over the analysis period. The Joint Agencies believe these methods result in a more accurate representation of marbled murrelet habitat and more accurately reflect an increase in nesting carrying capacity over the analysis period.

particular alternative. Instead, it is intended as a tool to determine how each alternative might perform compared to each other. The model used demographic information obtained through intensive field studies and available in published reports. It was based on a reasonable understanding and interpretation of murrelet ecology and habitat relationships, as well as detailed assessments of forest conditions in Washington, especially on DNR-managed lands.

On DNR-managed lands, the P-stage model was available to project future habitat growth and quality increase. This type of information was not available on non-DNR-managed lands, so Maxent[10] data were used for all other lands. Maxent does not project habitat into the future, so habitat quantity and quality were assumed to be static on non-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 population viability 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.

Population viability model predictions included in this RDEIS 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. Model predictions also must be considered in light of the assumption that habitat capacity will remain static on non-DNR-managed lands. This assumption was made because habitat changes on non-DNR-managed lands have not yet been modeled. 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 murrelet population decline:

- A “risk analysis” scenario was based on the assumption that both inland habitat loss and other chronic environmental stressors such as marine conditions are responsible for the murrelet population decline observed in Washington. This scenario used relatively pessimistic demographic rates that result in a declining murrelet population with less ability to use inland habitat as it develops.

- An “enhancement analysis” scenario assumed that loss of inland 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 inland habitat as it develops.

To focus on relative differences between the alternatives, murrelets in Washington were assumed to belong to two simplified subpopulations (on DNR-managed lands, and on non-DNR-managed lands), with habitat conditions artificially held constant on non-DNR-managed lands. Simulations of the

[10] Maxent is a type of habitat model.

Washington population assumed that the two subpopulations were connected by dispersal, while simulations of the population on DNR-managed lands alone assumed no dispersal. The model 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 67 percent greater than the carrying capacity[11] (*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 probability." The quasi-extinction probability is the probability of the population dropping below a certain fraction of the starting population. A population that has reached quasi-extinction may have too few adults to assure persistence of the species.

In interpreting the results of these simulations, readers should keep in mind that the results for the Washington population are greatly influenced by the assumption that murrelet habitat capacity will remain stable on non-DNR-managed lands. In fact, inland habitat is expected to increase on federal lands over the next 50 years as a result of the *Northwest Forest Plan*. Therefore, at least with the optimistic demographic rates used in the "enhancement analysis," one would realistically expect population growth in Washington beyond what is presented in the results of the simulations. This effect of a simplifying assumption used for the population viability model exemplifies the reasons that make it appropriate to view the population viability model results as a way to compare alternatives to one another, but not to make true projections about future marbled murrelet population sizes.

Detailed results can be found in the report (Peery and Jones 2018, Appendix C); results are briefly summarized here.

RISK ANALYSIS

When the population viability model focused on just the theoretical population on DNR-managed land, differences among alternatives in population response and the probability of quasi-extinction were distinguishable. This analysis considers both one-quarter and one-eighth of the starting population when evaluating for quasi-extinction. The DEIS reported quasi-extinction at one-eighth; the one-quarter threshold was added to the RDEIS because it offers the greatest distinction between alternatives.

Alternative F resulted in the greatest number of female murrelets (196) and the lowest quasi-extinction probability (36 percent if the quasi-extinction threshold is one-quarter and 7.6 percent if the quasi-extinction threshold is one-eighth). Alternative G was similar to Alternative F, with the second-highest number of female murrelets (194) and the second-lowest quasi-extinction probability (37 percent if the quasi-extinction threshold is one-quarter and 7.4 percent if the quasi-extinction threshold is one-eighth). Alternative B resulted in the lowest population size (123 female murrelets) and highest quasi-extinction probability (67 percent if the quasi-extinction threshold is one-quarter and 26 percent if the quasi-extinction threshold is one-eighth).

[11] The maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water, shelter, and other necessities available in the environment.

When the Washington population was evaluated, only small differences among alternatives could be seen in projected population size and the probability of quasi-extinction. During the 50-year model period, all alternatives had similar probabilities of quasi-extinction (31 to 34 percent if the quasi-extinction threshold is one-quarter, and 4.7 to 5.5 percent if the quasi-extinction threshold is one-eighth). Similarly, under all alternatives, after an initial annual decline of approximately 5 percent, populations continued a steady decline of approximately 1.0 percent per year for the remainder of the modeling period (ending populations ranged from 1,090 to 1,116 female murrelets).

The initial population decline of both the Washington population and the population on DNR-managed lands was related in part to the assumption (in keeping with the empirically measured current murrelet population trajectory) that the population began above carrying capacity. All alternatives allow for harvest of inland habitat in the first decade. Under alternatives A through E, this harvest results in a reduction of carrying capacity. The reduction of carrying capacity in these alternatives leads to differences in the severity and duration of the initial steep population declines. Alternatives B and D showed initial declines noticeably steeper than the baseline decline caused only by the initial, baseline difference between population size and carrying capacity (refer to Appendix C, Figure 4). Under alternatives F through H, carrying capacity is maintained or increases as inland habitat development equals or exceeds loss due to harvest in the first decade. Since the magnitude of the carrying capacity increase is small, these alternatives were not easily distinguishable from the baseline in the first decade.

ENHANCEMENT ANALYSIS

The hypothetical population limited to DNR-managed lands, assuming no dispersal, had very low probabilities of quasi-extinction under all alternatives, ranging from 0.25 percent for Alternative F up to 1.4 percent for Alternative B if the quasi-extinction threshold is one-quarter, and from 0 to 0.04 percent if the quasi-extinction threshold it one-eighth. All alternatives began with declining populations during the first two decades, except for alternatives F and G, which declined for one decade. After the respective declines, populations responded with gradual increases in response to increasing habitat for the remainder of the modeling period. Alternative F resulted in an ending population of 646 female murrelets, while Alternative B resulted in 378 female murrelets. Table 4.6.9 shows the mean ending female population sizes by alternative.

Similar to the risk analysis, few differences among the alternatives were apparent at the statewide scale. For the Washington population, probability of quasi-extinction (dropping to one-quarter or one-eighth of the initial population) was much less than one percent for all alternatives. While murrelet numbers initially declined in the first decade 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 (2,700 female murrelets) and Alternative B the smallest (2,453 female murrelets).

Table 4.6.9. Enhancement Analysis for Simulated Sub-Population on DNR-Managed Land, by Alternative

	Projected mean population sizes after 10,000 simulations (number of female marbled murrelets)							
Year	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
0	542	542	542	542	542	542	542	542
10	406	378	427	403	426	453	450	432
20	373	314	413	369	420	464	455	406
30	392	321	441	392	446	508	493	424
40	429	350	484	432	493	569	543	462
50	474	387	533	479	547	646	600	510

COMPARING MODELED POPULATION RESPONSES AMONG THE ALTERNATIVES

For the sub-population on DNR-managed lands, Alternative B resulted in the lowest ending populations and the highest probability of quasi-extinction. Assuming a quasi-extinction threshold of one-quarter, Alternative F resulted in the highest population by the end of the planning period and the lowest quasi-extinction probability. 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-managed lands. Refer to Figure 4.6.6.

As projected by the population viability analysis, marbled murrelet populations respond to changes in the quantity and quality of habitat available (Figures 4.6.10, 4.6.11). Alternatives that conserve and grow the largest acreage of habitat over the next 50 years are expected to produce the largest murrelet populations over the long term. The sensitivity analysis also demonstrated that habitat quality also is expected to influence murrelet populations. Harvest of high-quality habitat and interior forest habitat will cause larger initial reductions in populations than harvest of lower-quality or edge habitat (refer to Appendix C)

Model results for the Washington population of marbled murrelets showed no substantial difference in population size or quasi-extinction probability among the action alternatives (Figure 4.4.6, Appendix C).

Figure 4.6.9. Simulated Population Responses, by Alternative, for the Sub-Population on DNR-managed Lands Under the Enhancement Analysis (Copied from Peery and Jones 2018, Refer to Appendix C)

Projected murrelet population sizes as a function of proposed management alternatives. In each panel, the solid colored line represents the mean annual population size averaged over 10,000 simulations, the dashed colored lines represent the 5%, 25%, 50% (median), 75%, and 95% quantiles, and the grey lines represent a random subsample (n = 10) 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. Note that in this set of graphs, the line representing the 50% quantile (median) is not visible because it is obscured by the line representing the mean.

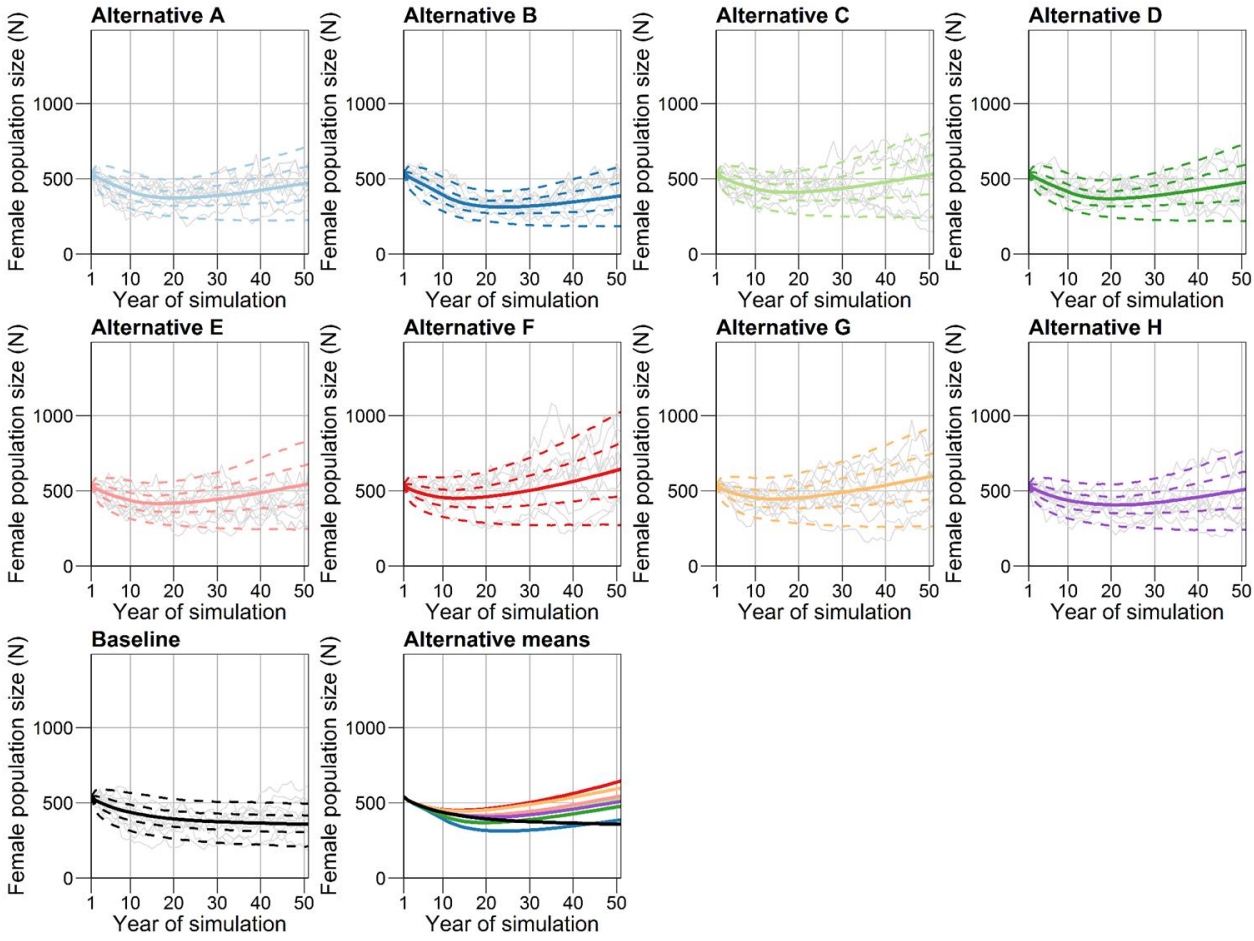


Figure 4.6.10. Relationship Between Population Viability Analysis Results (Female Murrelet Population on DNR-Managed Lands in Year 50 Under the "Enhancement" Scenario) and Raw Acres of Inland Habitat Projected for Year 50 by Alternative

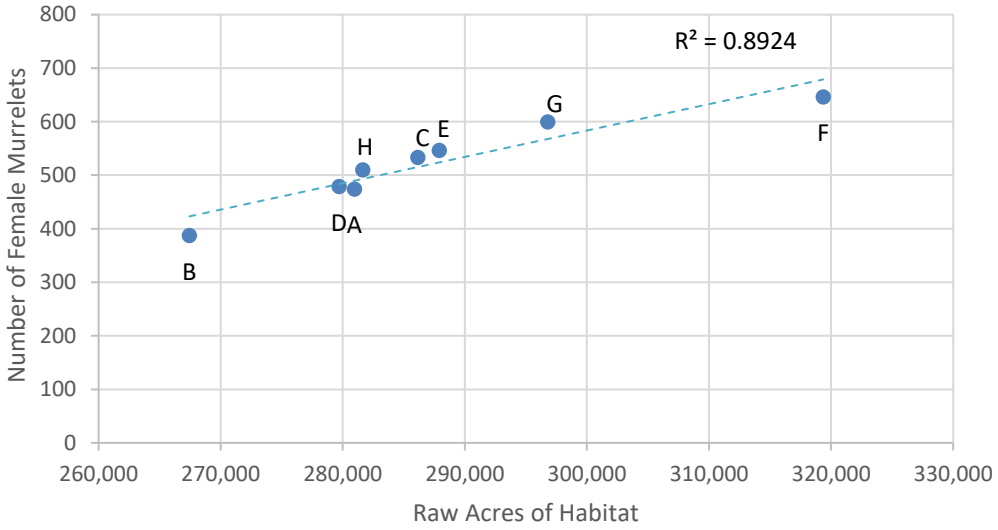
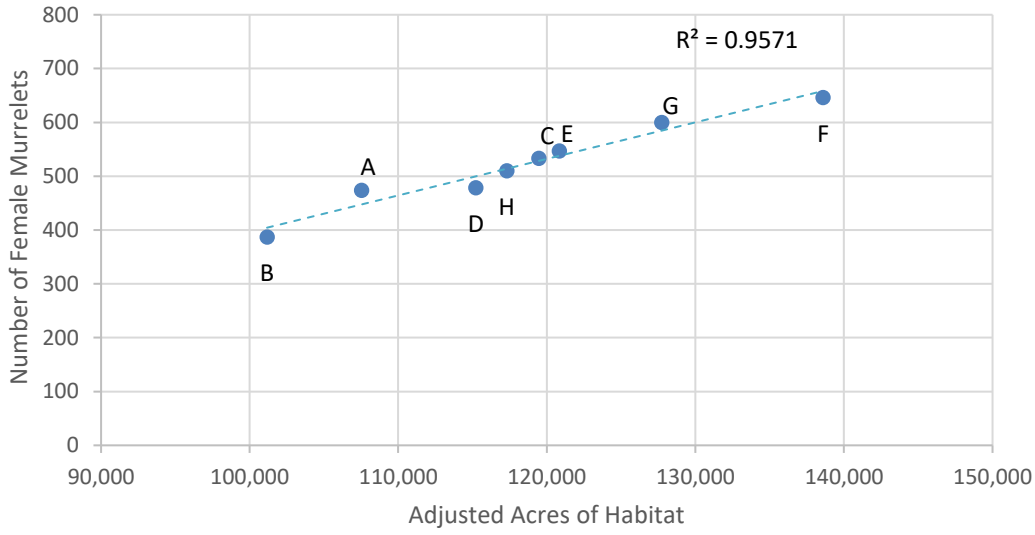
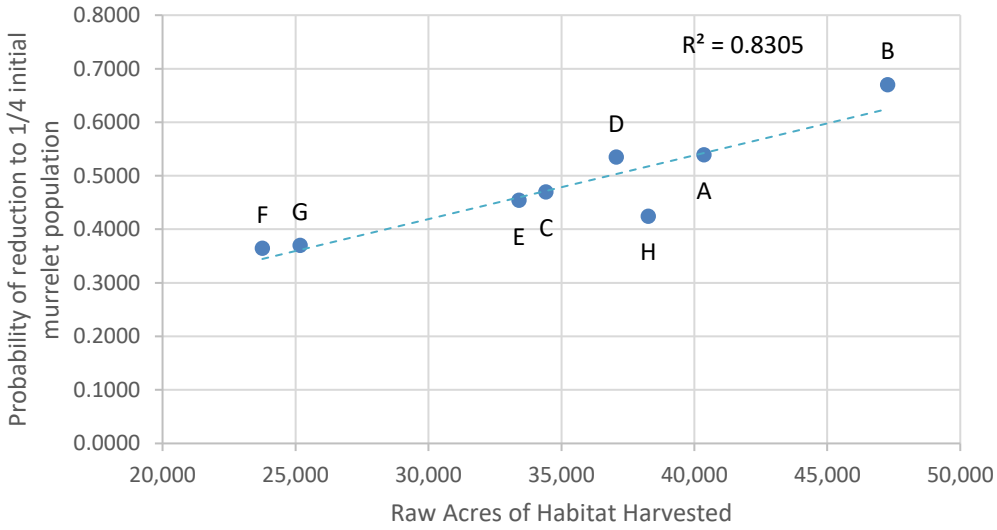


Figure 4.6.11. Relationship Between Population Viability Analysis Results (Female Murrelet Population on DNR-Managed Lands in Year 50 Under the "Enhancement" Scenario) and Adjusted Acres of Inland Habitat Projected for Year 50, by Alternative



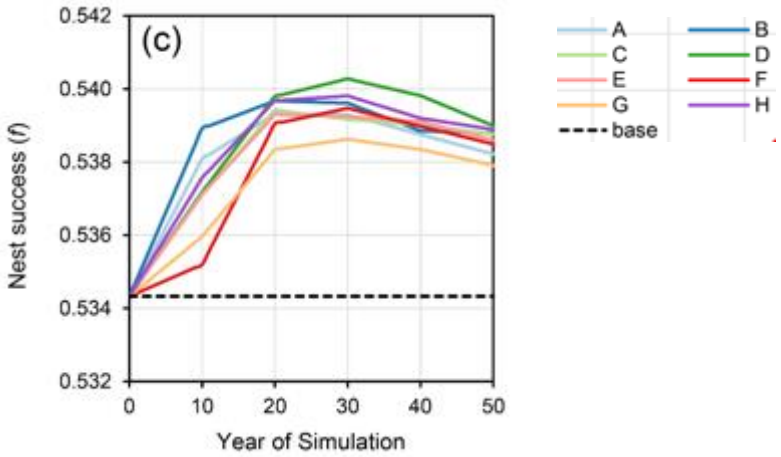
Although there is some correlation, raw acres alone do not determine whether the population reaches the quasi-extinction threshold. Consider Alternative H (Figure 4.6.12). Alternative H conserves a similar number of acres of inland habitat than other alternatives, but it has a lower likelihood of the female murrelet population declining to a quasi-extinction threshold of one-quarter of the current population (Figure 4.6.12). The reason for this lower likelihood is that Alternative H meters the harvest of habitat in the first decade of the analysis period.

Figure 4.6.12. Relationship Between Raw Acres of Habitat and Quasi-Extinction Probability



Nesting success is expected to increase, albeit by less than one percent, relative to initial nesting success under all alternatives. The highest rates of nesting success occur in decades 2 and 3, depending on the alternative. Alternative D results in the highest rate of nesting success, followed by Alternatives H, B, F, C, A, E, and G, but note that all increases are between 0.75 percent and 1 percent (Figure 4.6.13).

Figure 4.6.13. Nesting Success (Perry and Jones 2018)



HABITAT CAPACITY

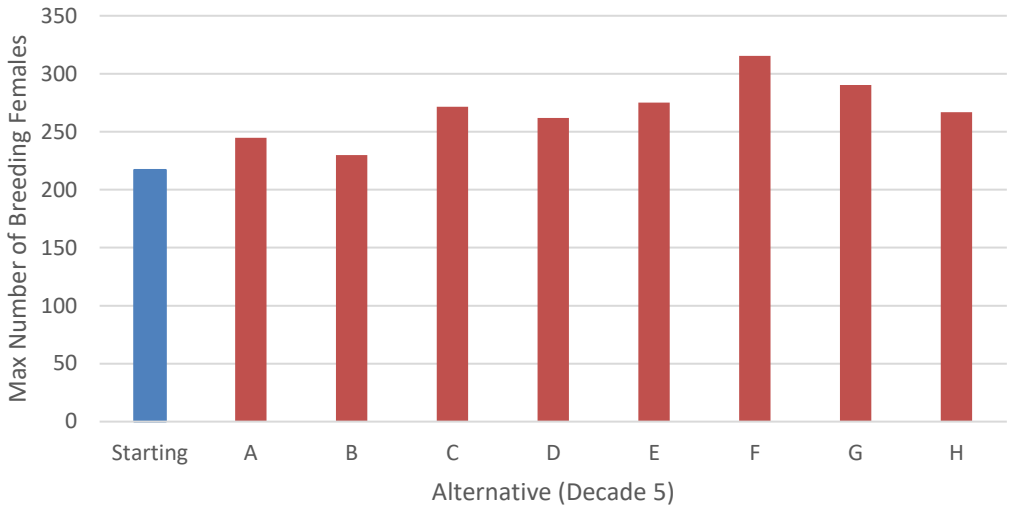
To provide context for the population viability analysis results, which considers how each alternative might perform compared to each other, the Joint Agencies added to this RDEIS a supplemental analysis of changes in habitat capacity.[12] The population viability analysis is based in part on the changing carrying capacity of inland habitat on DNR-managed lands. Both the "risk" and "enhancement" scenarios in the population viability analysis began with the assumption that of the 542 female murrelets associated with DNR-managed lands, 217 females would be able to find nesting sites (along with an equal number of males, for 217 breeding pairs) on the approximately 94,000 adjusted acres of habitat currently available on DNR-managed lands (432 adjusted acres per pair). As the amount of habitat changes, the carrying capacity also changes, leading to decreases or increases in the number of adults able to find habitat.

In addition to carrying capacity, the population viability analysis incorporates the processes of reproduction, mortality, and movement between populations, as well as year-to-year variation. To give context to the population viability analysis results, the Joint Agencies also looked at changes in habitat capacity over the next 50 years. Habitat capacity is a simpler measure, because it does not rely on assumptions about fecundity[13] or survival, and does not track changes in population over time. For each alternative, the Joint Agencies calculated habitat capacity by dividing the Decade 5 adjusted acres of habitat by 432 to derive estimates of the number of breeding females the habitat could support. In addition to nesting female murrelets, the population also would include an equal number of nesting male murrelets, plus some number of juveniles and non-breeding adults. The resulting numbers can be compared with the starting 217 females expected to be able to nest currently on DNR-managed lands.

Figure 4.6.14 shows the Decade 5 habitat capacity estimates for each alternative. Only Alternative B has a lower projected habitat capacity than Alternative A, and Alternatives C through H have higher habitat capacities. Ending habitat capacity is highest for Alternative F. All alternatives are projected to have a net increase in habitat capacity between now and Decade 5.

[12] The maximum number of female murrelets expected to breed if habitat use continues as estimated in the population viability analysis.
[13] The natural ability to reproduce.

Figure 4.6.14. Decade 5 Habitat Capacity Estimate for Each Alternative Compared with Current Habitat Capacity



Impacts to Marbled Murrelets by Alternative

In a new analysis for this RDEIS, the Joint Agencies examined the alternatives to describe their consequences for marbled murrelets. In contrast to the rest of the RDEIS, which compares alternatives to one another, and particularly to the no-action (Alternative A), the summary text and tables in this section are meant to provide information regarding each alternative in comparison to existing conditions.

In the tables in this section, the Joint Agencies summarize the effects of each alternative on inland habitat quantity and quality, and the resulting effects on murrelet populations (Table 4.6.10); each alternative's approach to reducing risk for murrelet populations (Table 4.6.11); and the effects of each alternative on the distribution of murrelets in Washington (Table 4.6.12).

POPULATION CHANGE

In general, the murrelet population is expected to be responsive to changes in the quantity of inland habitat. According to the population viability analysis, alternatives that release the largest acreage of inland habitat for harvest in the first decade will have the largest initial reduction in murrelet populations, and alternatives that conserve and grow the largest acreage of inland habitat over the next 50 years are expected to produce the largest murrelet populations over the long term (Figure 4.6.10). As shown by the sensitivity analysis in the population viability analysis, habitat quality also is expected to influence murrelet populations. Harvest of high-quality, interior forest habitat will cause larger initial reductions in populations than harvest of lower-quality habitat or habitat in edge condition. Alternatives that conserve and grow larger amounts of high-quality, interior forest habitat over the next 50 years are expected to produce the largest murrelet populations over the long term (Figure 4.6.11).

The population viability analysis, described in Appendix C and summarized in "Effects on Marbled Murrelet Populations" in this chapter, is a tool to compare alternatives to one another, rather than to make absolute predictions about future marbled murrelet populations. However, both the risk and enhancement scenarios in the population viability analysis were designed in keeping with current population declines. It is reasonable to conclude that the early population trajectories in the population viability analysis may be similar to the initial population response. Later population trajectories of the population viability analysis depend greatly on adult survival, as modeled, as well as other factors.

For comparison with the population viability analysis results, the Joint Agencies also examined habitat capacity, which was calculated as the maximum number of female murrelets expected to breed if habitat use continues as estimated in the population viability analysis. Table 4.6.10 summarizes the habitat and population changes modeled for each alternative.

POPULATION RISK

In addition to considering the likely population response to the alternatives, it is also important to consider risks to the murrelet population from the alternatives. Risks to individual murrelet nests, such as the risk of nest predation or the toppling of the nest tree, become population risks if enough individuals are affected.

Each alternative takes a different approach to protecting nests sites from these risks, including special habitat areas, emphasis areas, MMMAs, and buffers around known occupied sites. Most alternatives include 328-foot (100 meter) buffers around all or most known occupied sites. Some alternatives include 164-foot (50 meter) buffers in some areas, and sites with these smaller buffers would be subject to some edge effects, including predation risk and loss of habitat due to windthrow.

Special habitat areas are designed to recruit security forest, reduce edge and fragmentation, and improve productivity within occupied sites by reducing predation and disturbance. In order to maximize productivity of currently occupied sites, special habitat areas are designed to exclude active management within their boundaries, except in Alternative H. Under Alternative H, some thinning is allowed within special habitat areas. For example, thinning of non-habitat within occupied site buffers is allowed only to enhance or maintain security forest with windfirm canopies. Outside of occupied site buffers, thinning of non-habitat is allowed only within northern spotted owl habitat management areas with the goal of improving stands to develop into northern spotted owl habitat.

Emphasis areas, which are designed to provide security forest within 0.5 miles of occupied sites, reduce fragmentation, and grow new habitat, allow some active management within their borders. MMMAs cover more area than emphasis areas or special habitat areas and are designed to increase habitat around occupied sites via active management.

The population viability analysis included measures of population risk via the quasi-extinction probability. For each alternative, the Joint Agencies considered the modeled probability that, in the next 50 years under the "risk" scenario, the Washington murrelet population and the murrelet population on DNR-managed lands will reach one-quarter of its initial size. This quasi-extinction threshold is a representation of what may happen if murrelet populations continue on their current downward trajectories and allows for the greatest distinction between alternatives (Figure 4.6.12).

Other risks to murrelet populations were not captured by the modeling framework of either the population viability analysis or the impact and mitigation calculations. For example, as described in Appendix E, the P-stage habitat model may misclassify some forest habitat. Natural disturbances, including landslides, windthrow, and wildfires, may remove large or small areas of inland habitat, in addition to the acres released for harvest. Alternatives with more adjusted acres of mitigation have more buffer for these disturbances, whereas alternatives that have an impact greater than mitigation have no buffer for natural disturbance. Table 4.6.11 summarizes each alternative's approach to population risk.

DISTRIBUTION OF HABITAT

Effective murrelet conservation depends on conserving inland habitat, reducing short-term risks, and improving habitat distribution in strategic locations. Distribution of habitat is an aspect of the alternatives analysis that the population viability analysis does not address and is evaluated separately. The alternatives vary in the distribution of conserved habitat among the strategic locations and other high-value landscapes. (The strategic locations were selected as areas important to the distribution of murrelets because of the lack of federal lands in these areas and the proximity of DNR-managed lands to marine waters in Southwest Washington, the western portion of North Puget, and the northwest Olympic Peninsula.)

To evaluate habitat distribution, the Joint Agencies examined the change in adjusted acres between decades 0 and 5, and the mitigation or impact in each strategic location, which includes a time-adjustment factor. When impacts exceed mitigation, even if the end result is a larger amount of habitat in the strategic location, existing gaps in habitat distribution may persist or new gaps may be temporarily created.

Particular conservation areas were identified as being important to murrelet distribution at a local landscape scale. For example, in the northwest OESF, the Clallam area was identified as representing an important conservation opportunity that would result in a reduction in the distribution of habitat if not conserved. In Southwest Washington, some alternatives provide protection in key areas, but the level of conservation applied to the Elochoman area varies by alternative. In North Puget, DNR-managed lands bridge a gap between the marine waters to the west and inland habitat on federally managed lands to the east. Most special habitat areas, emphasis areas, and MMMAs in North Puget are in this gap and vary by alternative. Refer to the maps in the alternative profiles in Chapter 2 and Appendix F for more information.

The watershed analysis shown in Figure 4.6.6 also includes important information about changes in distribution of inland habitat under each alternative. Table 4.6.12 outlines each alternative's performance with respect to these aspects of distribution.

Table 4.6.10. Summary of Changes in Population and Habitat Modeled for Each Alternative, as Compared With Current Estimates

In this table, "PVA" stands for population viability analysis.

Population response	Existing Conditions	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Habitat released for harvest (acres)	n/a	37,000	47,000	34,000	40,000	33,000	24,000	25,000	38,000
High quality habitat released for harvest (acres with p-stage ≥ 0.47)	n/a	4,000	6,000	0	5,000	0	3,000	0	4,000
Habitat in Decade 5 (acres)	212,000	281,000	267,000	286,000	280,000	288,000	319,000	297,000	282,000
High quality habitat in Decade 5 (acres with p-stage ≥ 0.47)	103,000	179,000	172,000	187,000	180,000	188,000	203,000	197,000	183,000
Habitat in Decade 5 in interior forest (acres)	85,000	106,000	85,000	119,000	118,000	123,000	166,000	135,000	122,000
Habitat in Decade 5 (adjusted acres)	95,000	108,000	101,000	119,000	115,000	121,000	139,000	128,000	117,000
Habitat capacity in Decade 5 (nesting female murrelets)	217	245	230	272	262	275	315	290	267
PVA DNR murrelet population, year 10 (all female murrelets, risk scenario)	542	304	275	327	302	331	368	367	350
PVA DNR murrelet population, year 10 (all female murrelets, enhancement)	542	406	378	427	403	430	453	450	432

Population response	Existing Conditions	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
PVA DNR murrelet population, year 50 (all female murrelets, risk scenario)	542	151	123	172	151	175	196	194	178
PVA DNR murrelet population, year 50 (all female murrelets, enhancement)	542	474	387	533	479	547	646	600	510

Table 4.6.11. Summary of the Approach to Reduce Risk to Marbled Murrelets Incorporated Into Each Alternative

In this table, "LTFC" means long-term forest cover.

Risk Reduction Strategy	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Occupied sites	100-meter buffers on all sites, smaller mapped sites	No buffers on occupied sites	100-meter buffers, except for 50-meter buffers on sites > 200 acres in OESF	100-meter buffers, except for 50-meter buffers on sites > 200 acres in OESF	100-meter buffers, except for 50- meter buffers on sites > 200 acres in OESF	100- meter buffers on all sites	100-meter buffers on all sites	100-meter buffers on all sites
High-quality habitat	n/a	n/a	No harvest	n/a	No harvest		No harvest	n/a
OESF-specific conservation	n/a	n/a	n/a	n/a	n/a	100 meter buffers around all northern spotted owl old forest habitat	No harvest of current marbled murrelet habitat	n/a
Polygons of habitat identified by WDFW (Total 1,503 acres)	74% in LTFC (1,112 acres)	54% in LTFC (811 acres)	56% in LTFC (843 acres)	54% in LTFC (818 acres)	56% in LTFC (843 acres)	91% in LTFC (1,372 acres)	100% in LTFC (1,503 acres)	54% in LTFC (818 acres)

Risk Reduction Strategy	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Emphasis areas	n/a	n/a	7	n/a	7	n/a	8	n/a
Special habitat areas	n/a	n/a	20	32	31	n/a	31	29, thinning allowed in non-habitat
Marbled murrelet management areas	n/a	n/a	n/a	n/a	n/a	66	10	n/a
LTFC in conservation areas (emphasis area, special habitat area, MMMA)	n/a	n/a	67,000 acres	83,000 acres	83,000 acres	207,000 acres	139,000 acres	58,000 acres
"Risk" scenario probability of DNR population dropping below ¼ initial size	53%	67%	47%	54%	45%	36%	37%	42%
Net impact or mitigation (adjusted acres)	500	-6,000	3,500	-650	4,000	13,000	8,500	700

Table 4.6.12. Summary of the Approach to Distribution Incorporated Into Each Alternative

Distribution	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Southwest Washington (WA) change in adjusted acres between decades 0 and 5	1,608	-1,920	4,057	3,967	4,055	7,561	5,958	3,033
Southwest WA impact or mitigation	2,995	1,268	2,590	2,397	2,571	3,414	2,560	751

Distribution	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Elochoman special habitat area or MMMA	No	No	No	No	No	Yes	Yes	Yes
OESF/ Straits change in adjusted acres between decades 0 and 5	2,333	2,122	7,970	6,696	9,023	11,883	12,451	8,400
OESF/Straits impact or mitigation	1,356	-1,567	735	-399	1,303	2,722	3,742	434
Clallam emphasis area or special habitat area	No	No	Yes	No	Yes	No	Yes	Yes
North Puget change in adjusted acres between decades 0 and 5	1,252	297	4,617	2,780	4,996	10,433	6,450	3,930
North Puget impact or mitigation	-2,878	-3,113	-177	-1,938	54	2,663	927	-1,072
Acres in special habitat areas, or MMMAs in North Puget[a]	0	0	11,000	15,000	15,000	35,000	22,000	13,000

Distribution	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Watershed analysis	Habitat declines clustered in North Puget	Habitat declines clustered in North Puget, Straits, south-west WA	Habitat declines clustered in South-west WA, and in some areas of North Puget, Straits	Habitat declines clustered in North Puget, South-west WA, and in some areas of Straits	Habitat declines clustered in southwest WA, and in some areas of North Puget, Straits	Habitat declines in isolated areas of southwest WA, North Puget	Habitat declines clustered in southwest WA, and in isolated areas of North Puget	Habitat declines clustered in North Puget, southwest WA, and in some areas of Straits
Other notes			Includes additional special habitat areas outside of strategic locations	Includes additional special habitat areas outside of strategic locations	Includes additional special habitat areas outside of strategic locations		Includes additional special habitat areas outside of strategic locations	Includes unique special habitat area to reduce existing gap in range between OESF, southwest WA

[a] Not including acres in existing natural resources conservation areas

Conclusions: Changes in Habitat and Population Response

All alternatives increase the acreage and quality of inland habitat over the analysis period. These projected increases are likely positive impacts on the sub-population of murrelets on DNR-managed lands, even when considered against the ongoing 3.9 percent population decline. If 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 4.6.13.

Table 4.6.13. Comparison of Alternatives Based on Key Measures

Measure	Alternatives							
	A (no action)	B	C	D	E	F	G	H
Acres of habitat loss in first decade (not adjusted for quality)	37,063	47,272	34,417	40,357	33,404	23,754	25,170	38,264
Total unadjusted habitat acres (Decade 5)	280,945	267,434	286,130	279,708	287,906	319,347	296,783	281,627
Total adjusted habitat acres (Decade 5)	107,537	101,170	119,463	115,230	120,852	138,593	127,747	117,307
Acres of interior habitat by Decade 5 (percent change from Decade 0)	108,041 (28%)	86,719 (3%)	121,091 (43%)	120,163 (42%)	125,025 (48%)	167,982 (99%)	136,792 (62%)	123,583 (46%)
Decade to habitat recovery[14], adjusted acres	Decade 2	Decade 4	Decade 2	Decade 2	Decade 2	No net loss of adjusted acres	No net loss of adjusted acres	No net loss of adjusted acres
Decade to habitat recovery, raw acres (excluding stringers)	Never	Never	Decade 5	Never	Decade 5	Decade 3	Decade 4	Decade 5
Ending female population for sub-population on DNR-managed lands (risk/enhancement)	151/474	123/387	172/533	151/479	175/547	196/646	194/600	178/510
Probability of the DNR sub-population falling below one-quarter of the starting population[15] (risk/enhancement)	53% / 0.62%	67% / 1.4%	47% / 0.45%	54% / 0.67%	45% / 0.38%	36% / 0.25%	37%/ 0.27%	42%/ 0.45%

Alternative B reflects the most harvest of inland habitat in the first decade and never recovers initial level of raw habitat outside of stringers. Alternative D also never recovers starting raw habitat levels; however, Alternatives B and D do recover adjusted acres in decades 4 and 2, respectively. It takes three decades for

[14] Decade to habitat recovery refers to the time it takes for habitat growth in long-term forest cover to compensate for the habitat loss in the first decade as measured in adjusted acres.

[15] A 5 percent decline per year equates to a decline to one-eighth of the starting population in 40 years.

raw acres of habitat in long-term forest cover to exceed loss in Alternative F and five decades in Alternatives E and H. Alternative G recovers initial raw habitat in decade 4. It takes two decades for Alternative E to recover adjusted acres, and alternatives F, G, and H have no net loss of adjusted acres.

The population viability assessment shows that Alternative B has the smallest simulated population by the end of the analysis period, as well as the greatest quasi-extinction probability for marbled murrelet populations among the alternatives.

Alternatives C, D, E, and H are similar in the overall number of acres conserved and the quality of those acres. Although Alternative D proposes the most initial harvest of inland habitat outside long-term forest cover among these four alternatives, the overall value of the habitat retained and percentage of new interior habitat grown is higher than in the no action alternative.

Alternatives C, E and G conserve isolated stands of high-quality habitat, thus raising their overall habitat quality as compared to alternatives D and H. Alternatives C and E differ only slightly in population responses. Alternative G results in higher population responses than C and E. 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 approximately 10 percent fewer murrelets in the modeled marbled murrelet population than in Alternatives C or E. Alternative H is unique, in that some high-quality and some lower-quality habitat is conserved during the first decade through metering. The remaining habitat outside of long-term forest cover is released for harvest during the second decade. Conserving this habitat for the first decade maintains the nesting carrying capacity at baseline, resulting in no short-term decrease in the population due to harvest.

The larger area of long-term forest cover and fewer acres of harvest proposed under Alternative F results in a projected net habitat increase after the first decade, the most gain over time in interior forest habitat, the highest modeled population gains, and the lowest probability 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 Nesting Marbled Murrelets: Disturbance

Marbled murrelets use DNR-managed forests year-round. During the nesting season (April 1 through September 23 in Washington), they can be exposed to audio-visual stressors from a variety of land use activities that may have negative impacts on essential behaviors. Harvest and other forest management and forest use indirectly impact 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 edges (described in preceding sections), and other stressors 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; rock pit operations; and more.

A disturbance event is considered significant when an activity causes a murrelet to delay or avoid nest establishment, fly away from an active nest site, or abort an attempt to feed a nestling. Indirect effects of campgrounds and day-use areas include locally increased populations of nest predators. Such events are considered significant when they 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 by 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 4.6.14 are based on the assumption that disturbance patterns will be approximately constant over the term of the 1997 HCP 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 H) estimated for the middle of the term of the 1997 HCP, averaged across all alternatives. Cumulative disturbance can be estimated by multiplying acres disturbed annually by 51.

Table 4.6.14. Average Estimated Acreage of Inland 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)[a]
Group 1 (Includes green collecting, pre-commercial thinning, non-motorized trail use, minor road maintenance)	Ground-based noise and visual disturbance	≤328 feet (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	≤328 feet (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	≤328 feet (100 meters)	> 1 month	Increased predation risk, aborted feedings, adults flushing; potential injury and/or mortality	142
Group 4 (Includes timber harvest, motorized trail use, new road and bridge construction)	Ground-based noise and visual disturbance	≤328 feet (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	≤ 1,312 feet (400 meters)	>7 days, < 1 month	Hearing damage from blast noise (within 100 m), aborted feedings, adults flushing; injury; disruption of normal behaviors	52

Activity Group	Stressor	Distance	Duration	Response/Impact	Average habitat disturbed annually during nesting season (adjusted acres)[a]
Group 6 (Aerial herbicide application)	Aircraft noise	≤328 feet (100 meters)	< 7 days	Aborted feedings, adults flushing; disruption of normal behaviors	50

[a] These acres were not updated between the DEIS and the RDEIS because they are an average across alternatives in the middle of the term of the 1997 HCP and so are not likely to be significantly different.

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, Groups 3 and 5 disturbances 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 over 143 acres annually, and blasting (Group 5) within 328 feet (100 meters) of nesting murrelets also could result in injury and/or mortality over 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 additive impacts.

Estimates of acres of inland 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 4.6.15 summarizes how the conservation measures are expected to affect marbled murrelets.

Table 4.6.15. Summary of Resulting Effects of Key Proposed Conservation Measures on Disturbance

Conservation measure	Potential disturbance impacts addressed	Resulting effect
Limiting harvest and thinning activities (Table 2.2.5)	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.

Conservation measure	Potential disturbance impacts addressed	Resulting effect
Daily timing restrictions on forest health treatment activities in long-term forest cover under all Alternatives	Aborted feedings, adults flushing (flying from nest); 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, F, and H:** Creation of edge and audio-visual disturbance may occur as a result of some road construction through murrelet conservation areas including occupied sites, although consultation under Alternatives B, E, F, and H will likely minimize this risk. Habitat located outside occupied sites is subject to ongoing disturbance impacts from road construction. **Alternatives C, D, and G:** Occupied sites, buffers, and special habitat areas will not receive new impacts from roads unless road construction is required by state or federal law or emergency. Risk of road impacts to other resources 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 habitat throughout the analysis area may experience audio-visual disturbance from these activities.
Seasonally restricting installation and placement of harvest-related infrastructure (tailholds, guyline corridors, etc.)	Habitat removal, aborted feedings, adults flushing; potential disruption of nesting behaviors	Reduces audio-visual disturbance to all marbled murrelet conservation areas under all alternatives.
Limiting salvage and recovery activities during the nesting season under all alternatives (Section 2.2)	Aborted feedings, adults flushing; potential disruption of nesting behaviors	Reduced risk to 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.

Conservation measure	Potential disturbance impacts addressed	Resulting effect
Restricting both location and timing of blasting (Section 2.2)	Hearing damage from blast noise (within 328 feet [100 meters]), 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.
Limiting rock crushing and pile driving during nesting season (Section 2.2)	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 (Section 2.2)	Aborted feedings, adults flushing; potential disruption of nesting behaviors	Audio-visual disturbances from low-flying aircraft (flights conducted or contracted by DNR) 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 (Section 2.2)	Increased predation risk, aborted feedings, adults flushing; potential harm	**Alternatives C, D, and G**: 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 conservation areas, disturbance from maintenance activities will be eliminated during critical nest visiting and feeding hours. **Alternatives B, E, F, and H:** 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 From Natural Events

In addition to the direct impacts to inland habitat from harvest and related activities and the indirect effects from ongoing land use activities within and adjacent to inland 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 also could 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 long-term forest cover and insignificant within marbled murrelet-specific conservation areas. For example, only between 4 and 6 percent 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). That 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 impacts (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, does not buffer occupied sites, 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 4.6.16. Summary of Potential Impacts to Marbled Murrelets

Key question	Criteria	Measures	Potential impacts
How do the alternatives affect inland habitat, and how are changes to habitat quantity and quality expected to affect the marbled murrelet population?	Compliance with Endangered Species Act and 1997 HCP. Need, purpose, and objectives.	Amount and quality of inland habitat gained and lost.	All alternatives result in more habitat gained than lost over time, with improved habitat quality and softened edge effects, except for occupied sites under Alternative B. 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 two decades, growth of new habitat and development of higher-quality habitat outpaces this initial habitat loss. When adjusted for quality, impacted acres exceed acres of mitigation under Alternatives B and D. Impacted acres and mitigation are most closely aligned in Alternative H when factoring in habitat quality. Under Alternative E, G, and F mitigation acres exceed impacted acres by greater amounts. Alternative F conserves the most additional habitat overall and has the most increase in interior habitat over time. Alternatives C through H 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 long-term forest cover but will be minimized inside occupied sites, occupied site buffers, and special habitat areas. Risk of disturbance within marbled murrelet conservation areas is minimized to the highest degree under alternatives that contain special habitat areas (Alternatives C, D, E, G, and H). There is a slightly higher potential for disturbance in special habitat areas under Alternative H compared to Alternatives C, D, E, and G because thinning in non-marbled murrelet habitat in special habitat areas is allowed under Alternative H. Other conservation measures, described in Section 2.2, will limit the potential for disturbance. Given the relatively small number of acres involved for most disturbance categories, the conservation measures provide a minor benefit. Occupied site buffers are lacking under Alternative B so more disturbance related impacts are expected to occur under that alternative.
		Relative comparisons of population projections over time, including probabilities of quasi-extinction.	Alternatives B and D have the highest probabilities of quasi-extinction, respectively. If inland habitat is the primary limitation on murrelet population growth, all alternatives result in a reduced rate of population decline over the next 50 years, 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 strategic locations for marbled murrelet conservation? These locations include southwest Washington and areas close to marine waters, including OESF and Straits (west of the Elwha River) and North Puget	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* (USFWS 2012). Relative comparisons of future habitat development in strategic locations.	**Southwest Washington:** The no action alternative would protect approximately 84% of all known habitat in southwest Washington. Alternatives C through E would protect approximately 83% of habitat in southwest Washington. Alternative F protects the most habitat in southwest Washington, approximately 93%. Alternatives G and H protect 91% and 80%, respectively. Alternative B protects the least, 70% (significantly less than the no action alternative). **Close to marine waters:** Alternatives C, D, E, G, and H provide more murrelet conservation near the Strait (west of the Elwha River) than other alternatives. Alternatives C, E, G and H provide additional habitat in the OESF (including the Clallam Block) and Straits (west of the Elwha River). Alternatives C through H emphasize murrelet conservation in areas west of federal lands in North Puget (closer proximity to marine waters), and Alternatives G and F provides additional habitat in North Puget. Alternative F provides the most overall future habitat in strategic locations.

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 long-term forest cover
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 4.6.8).

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 "forest block" scale. For the purposes of this analysis, "forest block" signifies a contiguous area of DNR-managed land. The proposed conservation measures most directly affect recreation in forest 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 1997 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 1997 HCP provisions, and DNR policies for recreation planning will continue to be followed. Alternatives B through H 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 clarification 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 forest 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

Direct impacts to recreation are not anticipated in the popular DNR-managed forest blocks of Capitol, Tiger Mountain, Raging River, Green Mountain, Tahuya, and Elbe Hills state forests. These recreational forest blocks do not have marbled murrelet conservation areas designated under Alternatives B through H; therefore, the conservation measures will not directly affect the management and development of recreation in these areas. These forest blocks could be indirectly affected by the conservation measures if restrictions on recreation within marbled murrelet conservation areas shift more recreation to these forest block (refer to the subsequent subsection, "Indirect Impacts").

For forest 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 forest 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 forest blocks while current uses would remain, as highlighted in Table 4.7.1.

Table 4.7.1. Existing Designated Recreation in Forest Blocks With Marbled Murrelet Conservation Areas

HCP planning unit	Forest block	Type of facility impacted	Known areas with potential limitations on expansion
North Puget	Walker Valley	Motorized trails	Alternative F: MMMA encompasses the northeast portion of the trail system.
Columbia	Elochoman	Motorized trails	Alternative E: Emphasis Area encompasses a trailhead and ORV trail. Alternative F: MMMA encompasses a trailhead and ORV trails.
South Coast	Radar/Bear	Campgrounds	Alternative D: Two campgrounds are within special habitat areas. Alternative F: Two campgrounds are within a MMMA. Alternative H: Special Habitat area encompasses non-motorized trail
Straits	Port Angeles	Motorized trails	All alternatives have occupied sites and/or buffers that overlap motorized trail.
Straits	North Crescent	Motorized trails	All alternatives have occupied sites, buffers, and/or conservation areas that overlap motorized trail.
Straits	North Crescent	Campground	All alternatives have occupied sites and/or buffers that encompass a campground.
OESF	Coppermine	Campground	Alternatives B through H have occupied sites and/or buffers that encompass a campground.

HCP planning unit	Forest block	Type of facility impacted	Known areas with potential limitations on expansion
OESF	Reade Hill	Non-motorized trails	All alternatives have occupied sites, buffers, or conservation areas that encompass non-motorized trail

IMPACTS ON NEW OR EXPANDED RECREATIONAL OPPORTUNITIES: ALTERNATIVES C, D, AND G

Alternatives C, D, and G would restrict recreational development within occupied sites, buffers (including the 0.5-mile buffer in emphasis areas), and special habitat areas. These restrictions mean that the specific geographic areas limited for recreation will be more clearly defined, which could bring more certainty to planning new and expanded recreational opportunities.

Potential impacts to strictly limiting new and expanded recreation opportunities in these forest blocks include the following:

- Increased use of existing facilities and trails, requiring increased enforcement and maintenance.
- Increased volume of use within the forest block, with the possibility of people going off trails or building trails without permission from DNR, requiring increased enforcement and environmental mitigation.
- Development of other forest block more suitable for recreational development, where available.
- Decreased recreation in the forest 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 forest blocks 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 DNR.

Another potential impact of Alternatives C, D, and G involves the requirement to consult with 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 DNR needs 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 would like to pursue recreational activities in one of these places, DNR would conduct an impacts analysis and, if impacts were identified, 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 these decisions are made on a site-specific basis, it 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 likely will have a low to minimal impact on recreation opportunities. The marbled murrelet nesting season (April 1 through September 23) coincides with the most popular season for recreation in many forest blocks as well as the optimal timing for many maintenance activities. Staff would have to schedule maintenance work in marbled murrelet conservation areas outside of the daily timing restrictions during nesting season, but this work likely could be accomplished with reasonable accommodation. Some maintenance activities could reasonably occur outside of the nesting season.

IMPACTS ON NEW OR EXPANDED RECREATIONAL OPPORTUNITIES: ALTERNATIVE H

The conservation measures under Alternative H are the same as for alternatives B, E, and F for developing recreation opportunities within marbled murrelet conservation areas. Under Alternative H, however, DNR would retain the flexibility to decommission or abandon trails in occupied sites, occupied site buffers, and special habitat areas without consultation with USFWS.

Alternative H conservation measures would allow maintenance or improvements within the footprint of existing facilities, trails, trailheads, and recreational sites within occupied sites, occupied site buffers, and special habitat areas. These activities would either occur outside of the nesting season or, if conducted during the nesting season, following daily timing restrictions. These seasonal or daily restrictions could impact the length of time needed to complete some projects.

Alternative H conservation measures also prohibit conversion of non-motorized trails to motorized use within occupied sites, occupied site buffers, and special habitat areas.

Indirect Impacts

An indirect impact of limiting new or expanded recreation development in some areas is that it may increase recreational pressure in other forest blocks. Limiting recreation development could create public pressure to develop recreational opportunities in forest blocks that have not historically had designated recreation or in areas that are less environmentally suitable for recreation. There also is the potential for increased recreational use in forest blocks 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 forest block might result in increased recreational use of open forest roads, public pressure to expand into other areas, and the development of trails without DNR permission. Increased use, public pressure, and unauthorized trail building 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 forest blocks with marbled murrelet conservation areas could indirectly impact dispersed recreation. Dispersed recreation is accessed 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 forest 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 designate and manage recreational opportunities. 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 three to four decades. The Washington State Recreation and Conservation Office completed an assessment of supply of outdoor recreation facilities and opportunities in Washington (Recreation and Conservation Office 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. These pressures are likely to intensify over the next several decades as land available for recreation becomes more restricted. As a result, existing facilities and trails most likely will see more use and public interest will increase to develop new facilities and new trails (both motorized and non-motorized). There could also be an increase in unauthorized trails being created within DNR's forest blocks. Forest blocks with marbled murrelet conservation areas may experience public pressure for recreation where currently there is not much demand for recreation. If public recreational use and demand begin to impact marbled murrelet conservation areas, DNR may have to increase management and enforcement to limit recreational use of an area and stay consistent with the conservation strategies of the 1997 HCP.

Increases in recreational volumes or expanded recreational development can create conflicts with adjacent landowners, trust income-generating activities, or environmental responsibilities. A variety of stakeholders have an interest in how DNR manages state trust lands, including but not limited to the trust beneficiaries, environmental community, tribes, adjacent landowners, and the recreating public. In the future, if recreation on state trust lands starts to significantly impact the basic activities necessary to fulfill trust obligations, DNR will need to evaluate how to either manage or eliminate recreation, or compensate the trusts for impacts from recreation.

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. Pending recreation plans.	Use levels through life of the 1997 HCP (trends). Designated recreation that intersects with marbled murrelet conservation areas.	No impact to existing designated and dispersed uses are expected. 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 restrictions 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 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 consistency for road work and management among the HCP planning units (refer to Table 3.8.3 for an explanation of differences in road management under the no action alternative).

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 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, and 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 bin the following section.

Effects from Restrictions on Road Location and Road Work

The alternatives designate habitat that must either be 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 on specific natural resources, the consultation process outlined for Alternatives B, E, F, and H (described later in this section) 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 design standards would be applied.

NEW CONSTRUCTION AND RECONSTRUCTION: ALTERNATIVES C, D, AND G

Alternatives C, D, and G 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 for the process of assessing road location options, particularly in the North and South Puget HCP planning units. However, these limitations could result in constructing longer roads to avoid certain areas. Longer roads 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 also may be affected, which can have an effect on timber production.

Road reconstruction under Alternatives C, D, and G 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[16] activities in these areas because there would be no way to reopen the road again. For that reason, 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, D, and G for siting new roads, conducting road work on existing roads, and reconstructing decommissioned roads. Alternatives B, E, and F affect road reconstruction to a slightly lesser extent than Alternative C, D, and G 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 (refer to 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, D, and G which would not only remove habitat but also could 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 Long-term forest cover and introducing predators.[17] Only about 5 percent of habitat is currently impacted by the road edge effect.[18] 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.

NEW CONSTRUCTION AND RECONSTRUCTION: ALTERNATIVE H

Conservation measures for new road construction under Alternative H are also more flexible than under Alternatives C, D, and G. Alternative H conservation measures allow new road construction through occupied sites, occupied site buffers, and special habitat areas, if no other route is feasible. In occupied sites and buffers, DNR will consult with USFWS to minimize impacts.

[16] Road decommissioning reduces the need to maintain roads between long periods of timber harvest inactivity, which reduces the long-term maintenance costs of the road and decreases impacts from hauling and other traffic, sediment delivery, and flooding.
[17] Appendix G, “Long-term Forest Cover Focus Paper.”
[18] Refer to Section 3.6 and Appendix H, “Potential Impacts and Mitigation Focus Paper.”

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 typically dry marbled murrelet nesting season (April 1 through September 23). Working in wet conditions increases the risk of sediment delivery, reduces the ability to compact road fill or surfacing adequately, and increases damage to existing roads from equipment due to weak soil conditions. Allowing work to 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. Because of the additional acres in occupied sites, the number of culverts and bridges located within these areas would increase. The number of culverts located within occupied sites and buffers would increase from 212 to 287 and the number of bridges would increase 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 also would be prohibited. Alternatives C, D, G and H do not change this basic limitation, but they expand the areas where this prohibition would apply. 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. Increased haul trips on forest roads could increase wear and tear and exacerbate potential environmental impacts. More flexibility is provided under Alternatives B, E, and F, but restrictions on new pit development in the highest priority habitat still is anticipated.

Rock pits can include relatively large areas, and expanding existing rock pits in marbled murrelet conservations areas may have fewer adverse effects for 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 expansion 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 shift may not be necessary because most road work can be accomplished outside 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 increases from six to eight, and the number of rock pits within 0.25 mile of an occupied site increases from 27 to 38 under the action alternatives. (This increase 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	Alt. G	Alt. H
Occupied sites	0	0	0	0	0	0	0	0
Within 0.25 miles of occupied sites	34	49	40	38	37	31	35	45
Special habitat areas/MMMAs	n/a	n/a	8	23	23	58	23	6
0.5-mile buffer in emphasis areas	n/a	n/a	8	n/a	8	n/a	9	n/a
Total	34	49	56	61	68	89	67	51

Alternatives C, D, G, and H

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 marbled murrelet nesting season (when most road work occurs) would increase from 34 to 56 (Alternative C) or 61 (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 marbled murrelet 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, D, G, and H would be expected.

CRUSHING RESTRICTIONS (ALL ACTION ALTERNATIVES)

The conservation measures propose to restrict rock crushing within 360 feet (110 meters) of occupied sites. Within these areas, rock crushing must take place outside the marbled murrelet 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 360 feet (110 meters) of occupied sites, which is a decrease in distance from the interim strategy (0.25 mile). Within these areas, pile driving must take place outside the marbled murrelet nesting season when feasible; if pile driving must take place during 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 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 scenario 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, as required by the 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 in areas with road restrictions but could either remain stable or increase in non-marbled murrelet conservation areas where road construction is not as restricted. The use of road 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 could not be 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 also may be more limited, which could have indirect impacts to local economies. (Refer to “Socioeconomics” in this chapter.) 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) also could 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. These restrictions could result in indirect effects to other natural resources. Strictly limiting road construction in some areas also could 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 increased?	Forest practices rules. *Policy for Sustainable Forests.* 1997 HCP.	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 likely occur. Alternatives C, D, and G: 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, F, and H: New road development through marbled murrelet conservation areas would remove habitat, create new edge effects, and reduce the quality of the habitat. The consultation process outlined for Alternatives B, E, F, and H allows more flexibility than Alternatives C, D, and G to choose among the best locations with the fewest impacts. Indirect impacts also could 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

Key questions	Criteria	Measure	Potential impacts
			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, D, and G or restricted under Alternatives B, E, F, and H.

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.

Bonneville Power Administration Transmission Line Corridor (Upper Left to Center Right) Crossing State Trust Lands in the Green River Area Northwest of Enumclaw. (South Puget HCP Planning Unit)

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 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 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 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.

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 marbled murrelet nesting season.

DNR currently does not 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 Bonneville Power Administration transmission line corridors, which cross approximately 118 miles of DNR-managed lands in the analysis area. Table 4.9.1 illustrates the portion of Bonneville Power Administration rights-of-way that currently are located near proposed marbled murrelet conservation areas.

Table 4.9.1. Approximate Mileage of Bonneville Power Administration Rights-of-Way Potentially Affected by Marbled Murrelet Conservation Measures Described in Chapter 2

	Alternative							
	A	B	C	D	E	F	G	H
Miles	8.3	9.3	10.9	9.3	10.9	9.3	10.9	9.3
Portion of Total miles of BPA rights-of-way in analysis area	7%	8%	9%	8%	9%	8%	9%	8%

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 HCP Planning Unit near Goldbar (U.S. Route 2)
- South Puget HCP Planning Unit in the Green River Watershed (near Enumclaw)
- South Coast HCP Planning Unit east of the Long Beach Peninsula

Only the area in the South Coast HCP Planning Unit would have additional marbled murrelet conservation areas designated on both sides of an existing Bonneville Power Administration corridor. Alternatives C through H include conservation areas around the same corridor east of the Long Beach Peninsula. The length of the corridor included in the conservation area varies by alternative, with a maximum of about 2.5 miles (1.6 kilometers) under Alternative F.

Based on the conservation measures proposed, additional marbled murrelet 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.

New transmission projects also may 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

The Radar Ridge Communication Site in Pacific County (South Coast HCP Planning Unit). Photo: DNR

areas where marbled murrelet conservation areas would be established adjacent to an existing transmission corridor.

In addition, replacement projects may require expansion of the existing road networks. Alternatives C, D, and G would restrict new road construction within marbled murrelet conservation areas, which could cause conflicts for accessing facilities. Alternatives B, E, F and H provide more potential flexibility to construct roads using a consultation process between DNR and USFWS.

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 0 and 3 existing sites currently are 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 between 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 a Transmission Line Photo: Bonneville Power Administration

New leases for communication sites will be limited in occupied sites, special habitat areas, and the 0.5-mile buffers on occupied sites within emphasis areas under the proposed conservation measures for all action alternatives. Consultation between DNR and USFWS will be necessary to avoid impacts to habitat 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, new leases are 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 through H would 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 marbled murrelet conservation areas that would occur under Alternatives C through H (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 DNR and USFWS (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. Continued ability to produce revenue. Consistency with marbled murrelet conservation. Continued access to existing infrastructure. 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 adjacent to existing and high-potential future communications and energy-related uses.	The addition of marbled murrelet conservation areas and 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 become 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 lands that would be deferred from harvest under one or more of the alternatives.

Effects related to 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 by 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 through H 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, various amounts of land will be available for the full range of management options (refer to Section 4.11, "Socioeconomics"). 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 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 a 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 the impact 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 long-term forest cover, with the exception of special habitat areas (under Alternatives C, D, and E) and occupied sites. This work likely would 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 H. This reduction in local revenues in turn could affect government services that may support 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 (food stamps), Supplemental Security Income, State Family Assistance, and the Employment Security Department programs.

Collectively, 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. Alternatives C through H are expected to reduce demand for forest sector labor in western Washington. However, the distribution 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 on 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 1997 HCP?*
- *How do the action alternatives affect county and state government revenue from other sources over the life of the 1997 HCP?*
- *How do the action alternatives affect county employment levels over the life of the 1997 HCP?*
- *How do the action alternatives affect environmental services and non-timber economic activities over the life of the 1997 HCP?*

Evaluation Criteria

The action alternatives include proposed conservation measures that affect the operation and management of DNR-managed lands with marbled murrelet habitat in the analysis area. The alternatives do not provide a harvest schedule, which is a plan for future harvests.[19]

In this section, potential impacts to revenue are evaluated 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 therefore is based on the change of acres available for harvest using a weighted "operable acre" unit (developed and used for this RDEIS analysis only). Operable acres are weighted by their assumed operability potential.

- Uplands with general management objectives are areas where the 1997 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 conservation or hydrologic maturity objectives apply. These acres are weighted at 55 percent of their area because harvest area or volume removal is limited.
- Riparian areas are weighted at 2 percent of their area based on the actual harvest level in these areas over the past ten years.[20]

[19] The long-term conservation strategy will have implications for DNR's sustainable harvest calculation. In a separate action, DNR is updating the calculation, with a separate process for environmental review that analyzes potential harvest levels associated with long-term conservation strategy alternatives. Refer to discussion in Chapter 1, page 1-6. The current version of the financial analysis for that process is included as Appendix P.

- Deferred areas, and non-operable areas such as natural area preserves and natural resource conservation areas, have a weight of 0 because no harvest occurs in these areas.

Scale of Analysis

The scale of analysis in this section varies. 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. The threshold used for this analysis is a 25 percent reduction in DNR-managed operable acres for most counties and trusts. This threshold is used because it is assumed that counties can accommodate changes in revenue potential of this magnitude. This level of change is allowed between decades in the sustainable harvest level in the *Policy for Sustainable Forest* (DNR 2006a, p.25). This policy was analyzed under SEPA (DNR 2004) and approved by the Board of Natural Resources.

For Pacific and Wahkiakum counties, the threshold is set lower because of the relatively poor economic conditions in these counties and the importance of timber from DNR-managed lands to these counties' economies. 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." As described in Chapter 3, the economic conditions in Pacific and Wahkiakum counties have not changed markedly since the publication of Daniels (2004). 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

- **All trusts in the analysis area except Pacific and Wahkiakum State Forest Purchase and Transfer trusts**: Operable acres available for harvest 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 long-term revenue-generating capability.
- **Pacific and Wahkiakum State Forest Transfer and Purchase trusts**: Operable acres available for harvest in each of these trusts is lower than Alternative A, based on the threshold established for this analysis.

Employment

- **Each county in the analysis area except Pacific and Wahkiakum counties**: Operable acres in a county decrease by more than 25 percent compared to Alternative A.

[20] Acre weightings used in the 2016 DEIS were revised based on an analysis of harvest rates for different land classes between fiscal years 2005 and 2016.

- **Pacific and Wahkiakum counties**: Operable acres in each of these counties is lower than Alternative A.
- **Analysis area**: Operable acres in western Washington decrease by more than 25 percent compared to Alternative A.

Forest Tax

- **Each county in the analysis area except Pacific and Wahkiakum counties**: Operable acres 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 each of these counties is lower than Alternative A.
- **Analysis area**: Operable acres in western Washington decrease by more than 25 percent compared to Alternative A.

Sales and Other Taxes

- There is high uncertainty regarding the impact of the change in operable acres available for harvest on these tax revenues at the county 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 variation 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.

For county-level employment change impacts, two assumptions were made. One assumption is that, within a county, timber harvest volume is closely related to employment levels in timber-related jobs. Another assumption is 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 in this section compares 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 following sections.[21]

IMPACTS TO TRUST REVENUE FROM TIMBER HARVEST

One way to assess the different strategies is to calculate the "bare land value"[22] 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 that all lands are higher-productivity sites, and that each operable acre is planted with Douglas fir, Western red cedar, or Western hemlock and harvested in a variable retention harvest at age 50. 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 the trust compared to Alternative A. Alternatives C through H reduce the operable acres. The impacts to the trusts increase in this order: Alternative H, Alternative C, Alternative D, Alternative E, Alternative G, and Alternative F (Table 4.11.1).

Table 4.11.1. Change in Management and Bare Land Value From Alternative A

	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Bare land value change	$29 million	-$17 million	-$20 million	-$22 million	-$51 million	-$42 million	-$9 million

Another way to assess the impact is to look at the assumed annual value of timber sales that could have occurred in areas conserved under each alternative 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 32,000 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.

[21] DNR's sustainable harvest calculation process analyzes potential harvest levels, including more detailed financial analysis. Refer to Appendix P.

[22] 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 net future worth (NFW) is 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.

Alternatives B through H would provide greater implementation certainty for management than Alternative A. The anticipated result of greater implementation certainty is lower management costs. The magnitude of the reduction in costs is depends on the magnitude of future regulatory changes. Since these changes are not known, the benefit of implementation certainty is not known, but could be substantial.

Table 4.11.2. Change in Estimated Total Value of Timber Sales, by Action Alternative

Assuming Each Operable Acre Yields 32,000 Board Feet per Acre, the Sale Price of the Timber is $350 per Thousand Board Feet, and 1/50 of the Operable Acres Are Harvested Each Year.

	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
Timber sale value change	$ 4 million	-$3 million	-$3 million	-$3 million	-$8 million	-$6 million	-$1 million

CHANGES IN OPERABLE ACRES BY TRUST

For this analysis, lands are grouped either by trust (for the federally granted trusts[23]) or by benefiting county (for State Forestlands[24]). Tables 4.11.3, 4.11.4, and 1.12.5 show the trusts for which the operable acres in western Washington are 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 either does not change or increases compared to Alternative A.
- **Alternatives C, D, E, and G:** Pacific County State Forest Transfer, Pacific County State Forest Purchase, and Wahkiakum County State Forest Transfer trusts are adversely impacted.
- **Alternative F:** Pacific County State Forest Transfer, Pacific County State Forest Purchase, Wahkiakum County State Forest Transfer, and Whatcom County State Forest Transfer trusts are adversely impacted.
- **Alternative H:** Pacific County State Forest Transfer and Pacific County State Forest Purchase trusts are adversely impacted.

[23] Trusts supported by State Lands, which are lands granted to the state by the Federal government at statehood through the Omnibus Enabling Act of 1889.
[24] State Forest Purchase and State Forest Transfer Lands are combined for this analysis.

Table 4.11.3. Change in Operable Acres Available for Harvest in the Federally Granted Trusts

	Trust(s)	Alt. A (no action) Operable acres	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
			% changes in acres available compared to Alternative A						
Federally granted trusts	Agricultural School Grant	13,000	1%	0%	0%	-1%	-9%	-2%	-1%
	Capitol Building Grant	35,000	5%	-3%	-3%	-3%	-7%	-8%	-1%
	CEP&RI and CEP&RI transferred	16,000	3%	-4%	-6%	-4%	-9%	-4%	0%
	Common School and Escheat	229,000	3%	-2%	-2%	-2%	-6%	-6%	-1%
	Normal School	13,000	4%	-5%	-4%	-6%	-3%	-6%	-4%
	Scientific School Grant	24,000	2%	-2%	-1%	-2%	-16%	-6%	-1%
	University Grant (original and transferred)	17,000	7%	-12%	-20%	-17%	-10%	-18%	-11%
Other lands	Community College Forest Reserve	2,700	0%	0%	0%	0%	-2%	0%	0%
	Community Forest Trust	0	0%	0%	0%	0%	0%	0%	0%
	Land Bank	0	0%	0%	0%	0%	0%	0%	0%
	Water Pollution Control Division Trust Land	3,900	0%	-2%	0%	-2%	0%	-2%	0%
	Other	1	0%	0%	0%	0%	0%	0%	0%

Table 4.11.4. Change in Operable Acres Available for Harvest in the State Forest Trust Transfer Lands by County

State Forest Transfer Trust	Alt. A (no action) Operable acres	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
		% changes in acres available compared to Alternative A						
Clallam County	46,000	9%	1%	3%	-1%	4%	-3%	1%
Cowlitz County	7,000	0%	0%	0%	0%	0%	0%	0%
Grays Harbor County	1,600	4%	4%	4%	4%	-2%	4%	4%
Jefferson County	10,000	3%	2%	2%	2%	2%	2%	2%
King County	10,000	0%	-1%	0%	-1%	-3%	-1%	0%
Kitsap County	4,400	0%	0%	0%	0%	0%	0%	0%
Lewis County	21,000	0%	0%	0%	0%	-1%	0%	0%
Mason County	18,000	0%	0%	0%	0%	0%	0%	0%
Pacific County	7,400	9%	-6%	-11%	-6%	-17%	-6%	-2%
Pierce County	2,900	0%	-1%	0%	-1%	-5%	-1%	0%
Skagit County	43,000	0%	-2%	-1%	-2%	-4%	-3%	-1%
Snohomish County	36,000	0%	-2%	-2%	-2%	-5%	-4%	-1%
Thurston County	14,000	1%	1%	1%	1%	1%	1%	1%
Wahkiakum County	6,000	20%	-10%	-14%	-10%	-27%	-16%	7%
Whatcom County	15,000	0%	-3%	-3%	-4%	-25%	-6%	-1%
Total	242,000	3%	-1%	-1%	-1%	-3%	-3%	0%

Table 4.11.5. Change in Operable Acres Available for Harvest in the State Forest Purchase Trust Lands, by County

State Forest Purchase Trust	Alt. A (no action) Operable acres	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
		% changes in acres available compared to Alternative A						
Clallam County	140	14%	-5%	-5%	-5%	4%	-5%	-5%
Cowlitz County	170	0%	0%	0%	0%	0%	0%	0%
Grays Harbor County	20,000	2%	2%	2%	2%	2%	2%	2%
Jefferson County	10	0%	0%	0%	0%	0%	0%	0%
Kitsap County	50	0%	0%	0%	0%	0%	0%	0%
Lewis County	2,200	0%	0%	0%	0%	0%	0%	0%
Mason County	240	0%	0%	0%	0%	0%	0%	0%
Pacific County	3,500	8%	-24%	-42%	-24%	-36%	-24%	-23%
Pierce County	1,300	0%	0%	0%	0%	0%	0%	0%
Skagit County	1	0%	0%	0%	0%	0%	0%	0%
Snohomish County	1,300	0%	0%	0%	0%	0%	0%	0%
Thurston County	16,000	0%	0%	0%	0%	0%	0%	0%
Whatcom County	620	0%	0%	0%	0%	-10%	-10%	0%
Total	46,000	1%	-1%	-3%	-1%	-2%	-1%	-1%

Tax Revenue

FOREST TAX

Changes in harvest levels have direct impacts on the annual forest tax liability of operators on state trust lands. Harvest volume is expected to either remain the same or increase in each county in the analysis area 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, E, F, G and H, forest tax distributions from timber harvests on state trust lands are expected to decrease significantly in Pacific and Wahkiakum counties based on the reduction in area available for harvest. The impacts to Pacific County

increase in this order: Alternative H, C, E, G, D, and F. Impacts to Wahkiakum County increase in a slightly different order: Alternative H, C, E, D, G, and F.

All alternatives have a negligible impact on the operable acres of state trust lands subject to the forest tax in western Washington. 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 of Washington 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 Pacific county under the other alternatives, with impacts to revenue increasing in the following order: Alternative H, C, E, G, D, and F. In Wahkiakum County, the order of impacts from smallest to greatest is Alternative H, C, E, D, G, and F. However, the degree to which these impacts 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 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-managed lands likely will be insufficient to replace tax revenues lost under Alternatives C through H.

Employment

Potential impacts to employment are measured based on the expected change in operable acres. For the analysis area, the change in operable acres ranges from an increase of 3 percent under Alternative B to a decrease of 7 percent under Alternative F (Table 4.11.6).

Table 4.11.6. Change in Operable Acres in the Analysis Area, Compared to Alternative A

State Trust Lands in Analysis Area	Alt. A (no action)	Alt. B	Alt. C	Alt. D	Alt. E	Alt. F	Alt. G	Alt. H
	Operable acres	% changes in acres available compared to Alternative A						
Change in operable acres (percent)	643,000	20,000 (3%)	-11,000 (-2%)	-13,000 (-2%)	-15,000 (-2%)	-34,000 (-5%)	-28,000 (-4%)	-6,000 (-1%)

The harvest level is expected to increase relative to Alternative A (no action) under Alternative B. Employment may increase commensurately, if only slightly. Harvest levels are expected to fall under Alternatives C through H. Adverse impacts are expected in Pacific and Wahkiakum counties under Alternatives C through H due to decreased harvest volume. The impact of Alternative H on Pacific and Wahkiakum counties is expected to be less than alternatives C, D, E, F, or G. Declines in employment in these counties could be locally mitigated if the alternative results in more acres of thinning because thinning requires more labor per unit of volume to harvest (Mason and Lippke 2007). However, mill employment may be reduced if volume from thinning is less than from variable retention harvests. Additionally, Alternatives C through H decrease the area available for thinning; therefore, employment increases due to increased thinning are not expected.

Environmental Services and Non-Market Values

CARBON SEQUESTRATION

All the alternatives are expected to increase the amount of carbon sequestered on DNR-managed lands at a similar rate over the life of the 1997 HCP (refer to Section 4.2, "Climate"). As no 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 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 Section 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, such as salal. 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 on state trust lands. Therefore, no significant impacts to trust revenue or the public's economic wellbeing 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 for 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.

By decreasing the number of operable acres available for harvest, Alternatives C, D, E, F, G and H 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 Purchase and Transfer 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 H. 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 and below-average economic diversity, and are more heavily dependent on timber harvest for local government revenue, the economies of these counties are less able than other counties to tolerate a reduction in harvest volume.

Analysis Uncertainty

The distribution of marbled murrelet conservation areas, combined with existing conservation, results in potentially operable (harvestable) acres being scattered across the landscape. As a result, forest management activities may be constrained due to 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 H could be higher than anticipated. Likewise, Alternative B may not yield the expected increase in revenue compared to Alternative A.

Table 4.11.7. Summary of Potential Impacts to Socioeconomics

Key questions	Criteria	Measures	Potential impacts
How do the alternatives affect trust revenue over the life of the 1997 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 Transfer, Pacific County State Forest Purchase, and Wahkiakum County State Forest Transfer trusts under Alternatives C, D, E, and G.

Key questions	Criteria	Measures	Potential impacts
			Alternative F adversely impacts Pacific County State Forest Transfer, Pacific County State Forest Purchase, Wahkiakum County State Forest Transfer, and Whatcom County State Forest Transfer trusts. Alternative H adversely impacts Pacific County State Forest Transfer and Pacific County State Forest Purchase trusts.
How do the alternatives affect county and state government revenue from other sources over the life of the 1997 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 H.
How do the alternatives affect county employment levels over the life of the 1997 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 H.
How do the alternatives affect environmental services and non-timber economic activities over the life of the 1997 HCP?	Opportunities available.	Change in opportunities.	No measurable impacts identified.

Potential Mitigation for Adverse Impacts

The Washington state 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,[25] may be transferred into natural resource conservation areas (DNR 2013, RCW 79.22.060, 79.22.140.). The transfer requires compensation to the trusts 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.

The Washington State Legislature directed the Commissioner of Public Lands to appoint a marbled murrelet advisory committee (Laws of 2018, Ch. 255). This committee is tasked with developing recommendations that achieve the following:

[25] The State Forest Replacement Lands Program also applies to Skamania and Klickitat counties, which are outside the analysis area.

- Support maintaining or increasing family-wage timber and related jobs in the affected rural communities;
- Ensure no net loss of revenue to the trust beneficiaries due to the implementation of addition marbled murrelet conservation measures;
- Provide additional means of financing county services; and
- Contain additional, reasonable, incentive-based, non-regulatory conservation measures for the marbled murrelet that also provide economic benefits to the rural communities.

Implementation of recommendations from this committee may reduce the adverse socioeconomic impacts of some of the alternatives.

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 analysis area.

How Impacts Are Measured

Impacts will be measured based on a qualitative review of the potential for actions considered under 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 typically are 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

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 long-term forest cover and limiting road construction and new recreational facility development in marbled murrelet conservation areas. Alternatives C through H increase the total amount of long-term forest cover compared to the action alternative. Alternative B, while resulting in fewer total acres of long-term forest cover, adds 7,000 acres of occupied sites where harvest would be prohibited.

Pelton Wheel, Used to Power Historic Mines in DNR's Northwest Region. Photo: DNR

All action alternatives also would make some currently deferred lands available for potential harvest (refer to Chapter 2, Figure 2.4.1). Alternatives C through H would remove long-term forest cover designation from 1,000 to 4,000 acres in the marbled murrelet marginal landscape and other marbled murrelet high value landscapes, while Alternative B would remove long-term forest cover designation from approximately 24,000 acres in the analysis area (most in the OESF HCP Planning Unit). While change 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-managed 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 conservation 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 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 long-term forest cover, 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 long-term forest cover, while others, such as berries, may decrease within areas of mature and maturing forest. While localized changes in habitat conditions may

temporarily reduce forage for important species such as deer and elk within long-term forest cover, 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 long-term forest cover 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 (for example, 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 within marbled murrelet conservation areas may be abandoned under all action alternatives, which could interfere with access to some areas. In areas where access currently is 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 damage to cultural or historic sites is not expected.
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 long-term forest cover may reduce forage habitat locally for some game species, but overall abundance and distribution of species would remain stable or increase on state trust lands (refer to Section 4.5, "Wildlife"). Fish resources are not expected to be impacted (refer to Section 4.4, "Aquatic Resources").

4.13 Summary of Potential Impacts to Elements of the Environment

Impacts evaluated in this RDEIS 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 to the no action alternative, Alternative B would decrease the area of long-term forest cover by 24,000 acres (approximately 2 percent of DNR-managed forestland in the analysis area). Alternatives C through E would increase long-term forest cover by 17,000 to 22,000 acres, Alternative F would increase this area by 142,000 acres, Alternative G would increase long-term forest cover by 43,000 acres and Alternative H would increase it by 10,000 acres.

■ 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 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 management objectives of the 1997 HCP, *OESF HCP Planning Unit Forest Land Plan*, and natural areas management plans 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 (not including the marbled murrelet), would remain stable or increase on DNR-managed lands.

In areas where land would be “released” from its current conservation status, 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

Between 2001 and 2016, the marbled murrelet population declined at an average annual rate of 3.9 percent in Washington.[26] While the direct causes for ongoing marbled murrelet population declines are not completely known, the USFWS Recovery Implementation Team identified the most likely primary factors as the loss of inland habitat, including additive and time-lag[27] effects of inland 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 (USFWS 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).

The final HCP amendment must meet the Section 10 issuance criteria for issuing an incidental take permit. Part of the analysis undertaken by USFWS when issuing an incidental take permit is to consider whether an alternative jeopardizes the continued existence of a species. "Jeopardize the continued existence" is defined in 50 CFR §402.02 as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." This determination is made when USFWS completes a biological opinion on the issuance of the take permit for the HCP amendment.

The Joint Agencies 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 habitat on DNR-managed lands.

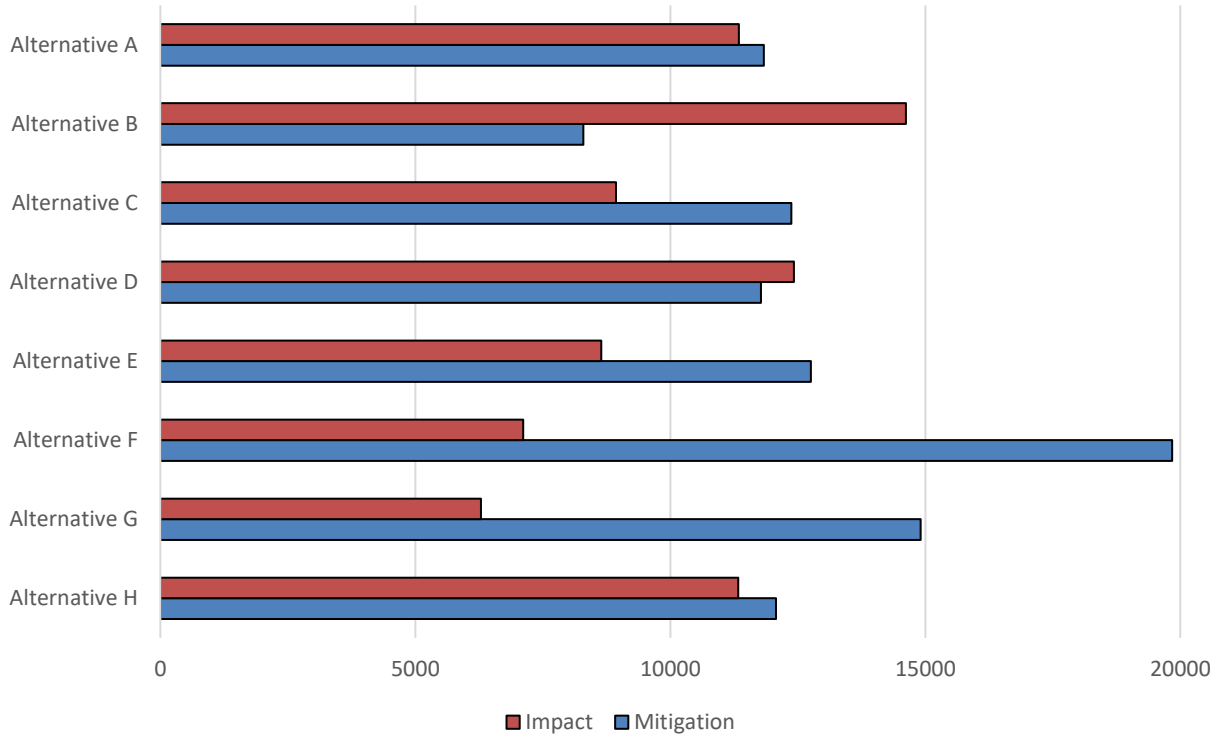
Two analytical approaches were used to evaluate the effects of the proposed alternatives on marbled murrelet habitat and populations. The acreage, quality (as influenced by stand condition and edge effects), and timing of habitat harvested and developed under each alternative provide a relatively direct measure of impacts. Potential consequences of each alternative relative to one other on the Washington murrelet population were evaluated with a population viability analysis model. This model explores two scenarios, both based on the assumption that habitat is the main influence on current population declines: 1) other factors compound the negative effects of insufficient habitat, making it difficult for murrelet populations to respond to increases in habitat availability (risk scenario), and 2) murrelet survival and reproduction are sufficient to allow for population growth as habitat increases (enhancement scenario).

[26] Due to reduced sampling efforts starting in 2014, statewide trend estimates for Washington are only available up to the year 2016 (Pearson and others 2018). This population trend is different than that used in the population viability analysis (a decline of 4.4 percent). The population viability analysis is described in this chapter and Appendix C.

[27] Time lag means a population response that occurs many years after the loss of inland habitat.

For alternatives A through E, 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. However, impacts are not fully mitigated in all alternatives. 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 Alternatives B and D (Figure 4.13.1).

Figure 4.13.1. Acres of Habitat Loss (Impact) and Gain (Mitigation) by the End of the Planning Period, by Alternative and Adjusted for Quality



The following section summarizes data for the alternatives on population size (numbers), reproduction, and distribution of marbled murrelet. This section does not replace analysis in the biological opinion produced by USFWS as part of issuing an incidental take permit.

Population Size

The population viability analysis shows that alternatives C, E, F, G and H could result in a larger murrelet population than under Alternative A. These differences were distinguishable at the scale of DNR-managed land. The population viability analysis showed little distinction between alternatives at the statewide scale, in term of population size or quasi-extinction probability.

In summary, the population viability analyses suggest that relative to the other alternatives, Alternative B results in the highest risk of local declines and the smallest projected local population sizes during the

modeled planning period. Alternatives F and G are projected to result in the lowest risk of local declines, and Alternative F has the largest projected local population sizes, with intermediate results projected under Alternative A and Alternatives C through E, G and H.

Reproduction

Successful reproduction is required to maintain marbled murrelet populations. In addition to the quality and quality of habitat available in the forest environment, reproduction also is impacted by predation and disturbance. The alternatives support marbled murrelet reproduction by reducing disturbance. Alternatives F, G, and H provide 328-foot (100-meter) buffers around all occupied sites to reduce the risk of predation and natural disturbance. Alternative A also has 328-foot (100-meter) buffers, but around smaller occupied sites. Alternatives, C, D, and E have 328-foot (100-meter) buffers around most occupied site, but applies 164-foot (50-meter) buffers on occupied sites over 200 acres in the OESF HCP Planning Unit. Alternative B does not include buffers, which could result increased predation and disturbance of occupied sites. Conservation measures described in Chapter 2 reduce disturbance from management activities and recreation.

In addition to occupied site buffers, special habitat areas, emphasis areas, and marbled murrelet management areas all are intended to provide security forest surrounding murrelet habitat. Each type of conservation area takes a slightly different approach to supporting murrelet reproduction by reducing the likelihood of predation and natural disturbances. In alternatives C, D, E, and G, special habitat areas are also intended to reduce anthropogenic disturbances. Alternatives A and B do not include any of these strategies. Alternative F includes marbled murrelet management areas; alternatives D and H include special habitat areas; alternatives C and E include special habitat areas and emphasis areas, and Alternative G includes all three strategies.

Distribution

Under all alternatives except Alternative B, there are more acres of raw habitat, adjusted habitat, and interior forest habitat in Decade 5 than current conditions in all landscapes. Additional analysis at the watershed scale shows that in Decade 5, adjusted habitat acres will increase in most watersheds in the analysis area under alternatives C, D, E, F, G and H. However, all alternatives include net declines in habitat in some watersheds. In Alternative F, these declines affect only a few isolated watersheds, whereas in Alternative B, large clusters of watersheds are projected to experience habitat declines in all three of the strategic locations.

However, as shown in Table 4.6.4, impacts exceeds mitigation in some strategic locations under some alternatives. Notably, impacts exceed mitigation in the North Puget strategic location under alternatives A, C, E, and H (even though mitigation exceeds impacts in these alternatives at the analysis area scale).[28] The reason is the time it takes for habitat to develop as mitigation in this strategic location. Therefore, there will be a period of time, up to several decades, when there will be less habitat available in North

[28] Impacts exceeds mitigation in both the North Puget strategic location and the analysis area as a whole under alternatives B and D.

Puget than there is now. Only Alternatives B and D result in greater impacts than mitigation in OESF and the Straits west of the Elwha, and only Alternative B shows greater impacts than mitigation in Southwest Washington.

At a smaller scale, alternatives vary in their conservation of specific areas such as the Clallam area in OESF and the Straits, the Elochoman area in Southwest Washington, and areas to the west of federal lands in North Puget. Alternatives A and B include no conservation areas (emphasis areas, MMMAs, or special habitat areas) in these areas. Alternatives C, E, G, and H provide conservation areas for the Clallam area. Alternatives F, G, and H provide conservation areas for the Elochoman area. West of federal lands in North Puget, only Alternatives C thought H include conservation areas. In order from least to most acreage in conservation areas in the North Puget, the alternatives are C, H, D, E, G, and F.

■ 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 to 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/ or easements, shifting demand to lands elsewhere within the analysis area. Existing facilities, easements, leases, and land uses would largely remain 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 likely would 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 will 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 entire analysis area. The overall change in operable acres ranges from a 3 percent increase under Alternative B to a decrease of between 1 and 5 percent for Alternatives C through H.

Federally granted trusts (trusts supported by State Lands) would experience gains in operable acres under Alternative B (increases between 1 and 7 percent) and reductions under alternatives C though H. Reductions vary by alternative and trust but are under 10 percent with two exceptions. First, operable acres are reduced on the University Trust by more than 10 percent under alternatives C through H, with a maximum reduction of 20 percent under Alternative D. Second, operable acres are reduced on the Scientific School Trust by 16 percent under Alternative F.

On State Forest Transfer and State Forest Purchase lands, which benefit counties, operable acres remain stable or increase under Alternative B. Under the other alternatives, operable acres remain stable, increase or decrease depending on the county. The largest changes in operable acres are on the State Forest Purchase Trust in Pacific County, with declines of 23 to 42 percent under alternatives C through H. The largest changes in operable acres are on State Forest Transfer Lands in Wahkiakum County, where operable acres decrease 10 to 27 percent under alternative C through G. Under Alternative H, operable acres on State Forest Transfer Lands in Wahkiakum County increase 7 percent. State Forest Transfer Lands in Pacific County decline by 2 to 17 percent under the action alternatives. Under Alternative F, operable acre declines of greater than 10 percent are expected on State Forest Transfer Land in Pierce and Whatcom counties.

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 H, 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 County is most likely to be adversely impacted by Alternatives C through H. Wahkiakum County is most likely to be adversely impacted by alternatives C through G. 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 G, and Alternative H for Pacific County only, 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 1997 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. Thus active management of forest resources can largely continue, following clear parameters for seasonal timing restrictions and disturbance buffers. 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.