

Chapter 4

ENVIRONMENTAL CONSEQUENCES

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Environmental Consequences

This chapter identifies any potential impacts under each alternative on the affected elements of the environment described in Chapter 3.

Identifying Impacts

The analyses in the section consider impacts from different sustainable harvest levels. The alternatives do not propose changing DNR policies or changing how DNR complies with state or federal law. This chapter, along with Chapter 5, considers potential direct, indirect, and cumulative impacts that could occur to natural resources due to the alternatives. It is the intent of this chapter to assess and understand, to the best we can, what impacts might occur to elements of the 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 affected by the alternatives.

■ Evaluation criteria and measures

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

Evaluation criteria rely on the existing conservation or management objectives, policies, or rules that are being 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 DEIS is designed to meet the requirements of SEPA. SEPA requires the DEIS to evaluate adverse impacts.

CONSIDERING SCALE AND CONTEXT

The analysis area covers over 1.4 million acres of DNR-managed land. The evaluation of impacts must consider whether identified potential impacts are significant relative to scale and context. The impact of an alternative to a single forest stand, for example, may not be significant when looked at in the context of DNR-managed lands in Western Washington. The alternatives are evaluated at the analysis-area scale with consideration given to smaller scale impacts.

CONSIDERING INTENSITY

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

■ Existing documents

Existing documents contain analyses relevant to the current proposal. The following analyses in existing documents are incorporated by reference as part of this draft environmental impact statement (DEIS):

- *Final (Merged) Environmental Impact Statement: Habitat Conservation Plan* (DNR 1998)

This document analyzed the impacts of implementing of the 1997 HCP. Sections incorporated by reference are the analyses of impacts to northern spotted owl (Section 4.2.1), and riparian ecosystems (Section 4.2.3) in the five west-side planning units, and the analyses of other species and habitats (Sections 4.5.1 through 4.5.4), and water quality (Section 4.8.2) in all Western Washington planning units.

- *Final Environmental Impact Statement on the Policy for Sustainable Forests* (DNR 2006b)

This document analyses the impacts of implementing the *Policy for Sustainable Forests*. The analyses in this document are incorporated by reference in their entirety.

- *Final Environmental Impact Statement for the Proposed Issuance of Multiple Species Incidental Take Permits or 4(d) Rules for the Washington State Forest Practices Habitat Conservation Plan* (NMFS and USFWS 2006)

This document analyses the impacts of implementing forest practices rules. Analyses incorporated by reference are the analyses of impacts to water resources and riparian and wetland processes due to implementation of the forest practices rules regarding roads in Western Washington.

- *South Puget HCP Planning Unit Forest Land Plan Final Environmental Impact Statement* (DNR 2010)

This document analyses the impacts of implementing the *South Puget HCP Planning Unit Forest Land Plan*. This forest land plan helps DNR meet policy objectives. The analyses in this document are incorporated by reference in their entirety.

- *Olympic Experimental State Forest HCP Planning Unit Forest Land Plan Final Environmental Impact Statement* (DNR 2016a)

This document analyses the impacts of implementing the OESF Forest Land Plan. This forest land plan helps DNR meet policy objectives and manage the OESF on a day-to-day basis. The analyses in this document are incorporated by reference in their entirety.

- *Draft Environmental Impact Statement on a Long-Term Conservation Strategy for the Marbled Murrelet* (DNR 2016c).

This draft document analyses the impacts of six alternatives for a long-term conservation strategy for the marbled murrelet. Five of the six alternatives are incorporated into the sustainable harvest calculation alternatives analyzed in this DEIS. The description of the affected environment and the environmental consequences from the *Draft Environmental Impact Statement on a Long-Term Conservation Strategy for the Marbled Murrelet* are incorporated by reference into this DEIS.

4.1 Earth: Geology and Soils

Analysis question

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

Evaluation criteria

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

Scale of analysis

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

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

Risk of landslides

Lands identified as potentially unstable would continue to be managed as provided for under current regulations, policies, and procedures, which are designed to minimize landslide risks. For these reasons, there is no expected increased landslide risk compared with current conditions

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

Effects on soil productivity

Timber harvest activities are implemented with best management practices defined by the forest practices rules and the 1997 HCP (refer to photo at right). By implementing these practices, adverse impacts to soil productivity due to erosion, compaction, or landslides are not expected to occur under any alternative.



Standard best management practices to minimize erosion include placing crushed surface rock on roads

Conclusions

Under all alternatives, including the no action alternative, DNR would continue to minimize the potential for landslides and damaging impacts to soils through the existing regulatory framework and through best management practices formally established in the forest practices rules. Table 4.1.1 summarizes these conclusions.

Table 4.1.1. Summary of Potential Impacts to Geology and Soils

Key questions	Criteria	Measure	Potential impacts
Do the alternatives affect the potential for landslides or increase soil erosion or compaction within the analysis area?	<p>Whether the alternatives reduce DNR’s ability to protect soils.</p> <p>Whether the alternatives are consistent with Washington state forest practices rules and other best management practices to protect potentially unstable slopes.</p> <p>Whether the alternatives increase potential for soil damage from forest management activities.</p>	Acres of potentially unstable slopes.	No alternative increases landslide potential or increase risks to soil productivity. All alternatives retain the existing regulatory framework for managing potentially unstable slopes and for minimizing soil impacts and retain procedures for evaluating slope stability. The existing regulatory framework was designed to minimize impacts from activities.

4.2 Climate

This section evaluates possible relationships between sustainable harvest calculation alternatives and climate change. The evaluation examines DNR-managed lands through different lenses. The section first examines how the alternatives may potentially contribute to climate change through a carbon assessment. Following that, the analysis examines any effects climate change may have on the alternatives or their impacts and whether the alternatives exacerbate the impacts of climate change on elements of the environment.

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 the 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 *Olympic Experimental State Forest HCP Planning Unit Forest Land Plan Final Environmental Impact Statement* (DNR 2016b). The carbon method implemented herein 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 here 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.

Scale of analysis

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

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

Summary of direct, indirect, and cumulative impacts

Carbon sequestration

Carbon sequestered in forests

All forest-related components, also known as pools, analyzed in this chapter are described in Table 4.2.1. Each pool was calculated separately based on the unharvested tree volume estimated from DNR's sustainable harvest model projected over time, and all forest-related carbon pools were summed together in this analysis.

Table 4.2.1. Pools of Stored Carbon 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 that 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 later in the chapter.

Table 4.2.2. Pools of Stored Carbon 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 carbon emissions from a tree begin the same year the tree is harvested. For example, Smith and others 2006 assumes 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. Carbon emitted from that harvested tree only 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 decay. 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 all DNR-managed state lands, we used the average greenhouse gas emissions reported by Sonne 2006 across all modeled scenarios of 9.8 tonnes of CO₂ equivalent per hectare (or 1.08 tonnes of carbon per acre) over a 50-year rotation period. DNR applied this emission value to the total area harvested and thinned per decade (Figure 4.2.1).

Comparison of the alternatives

Under each alternative, more carbon was sequestered than emitted in both the 2015–2024 period and over a 5-decade period. Compared to each other, differences in net amount of carbon sequestered across all alternatives is small. In the planning decade, the action alternatives all sequester more carbon than the no action alternative. Over 50 years, Alternative 5 sequesters 1 percent more carbon than the no action alternative, while Alternatives 3 and 4 sequester less than 0.3 percent less carbon than the no action alternative. Alternative 2 sequesters 1.4 percent less carbon than the no action alternative. However, all alternatives result in more sequestered carbon relative to current conditions (Figure 4.2.2).

Figure 4.2.1. Change in Carbon Sequestered and Emitted From Current Conditions Under Each Alternative in the Planning Decade (A) and Through the End of Five Decades (B)

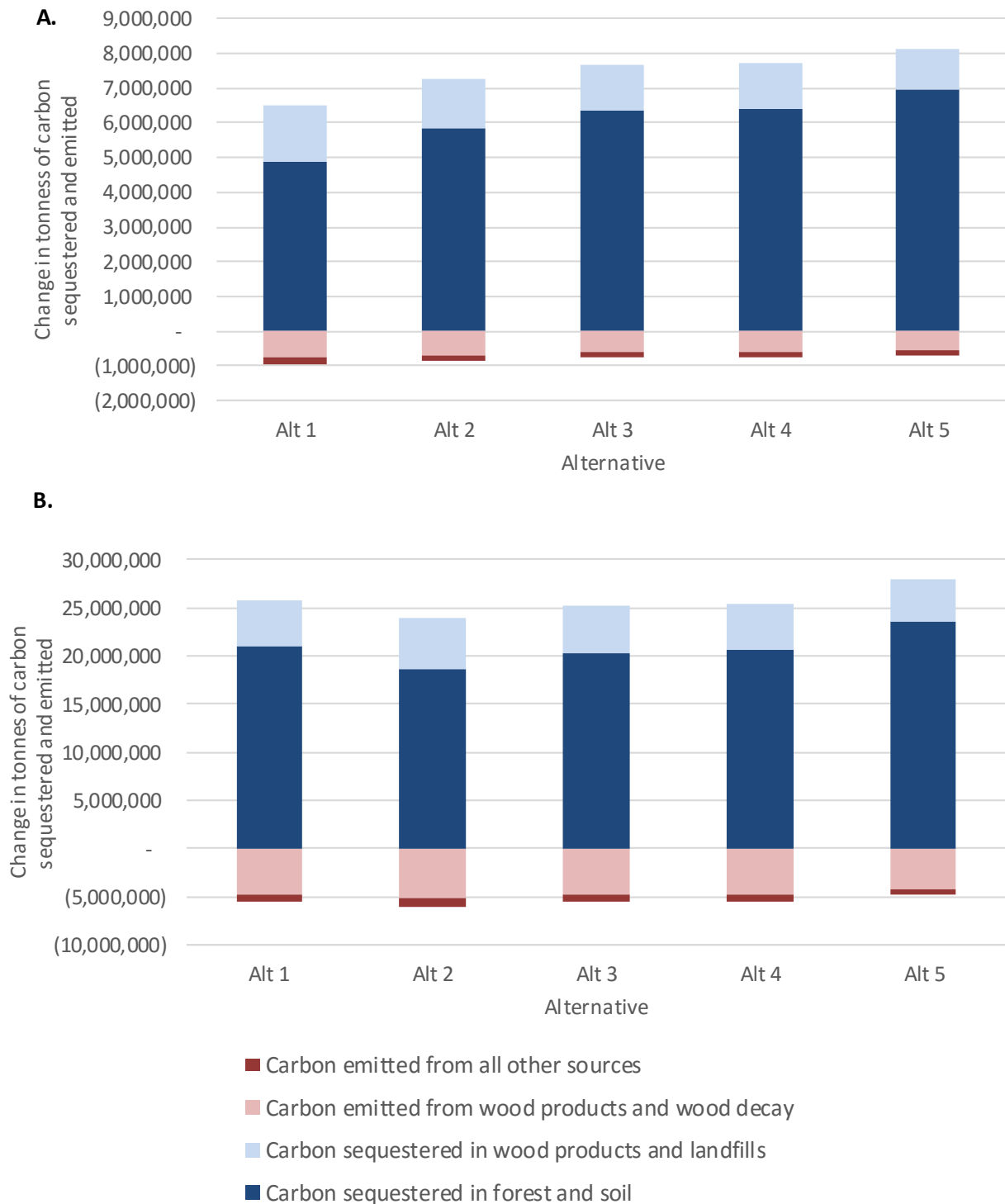
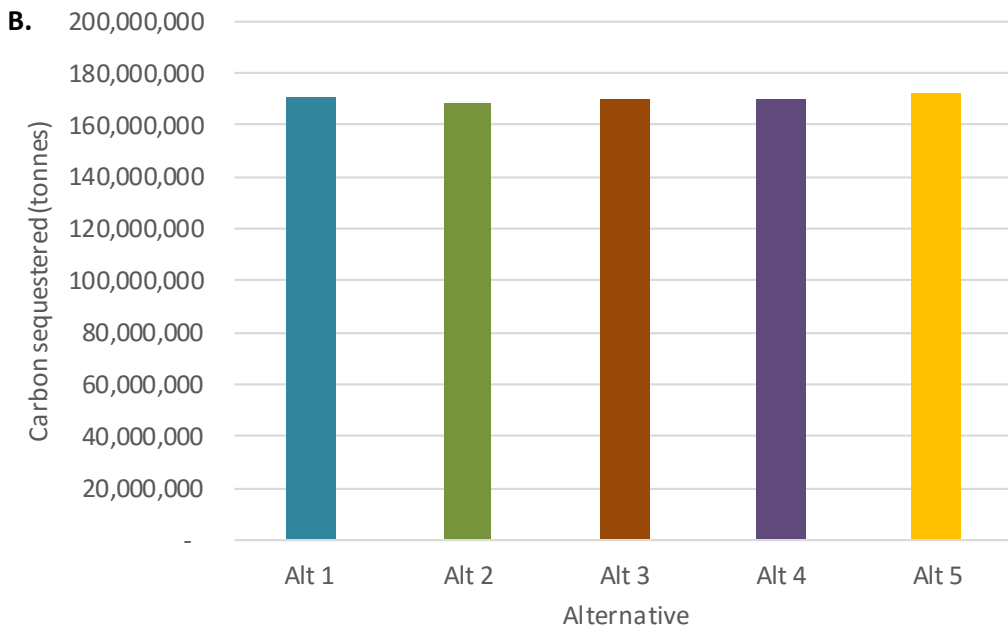
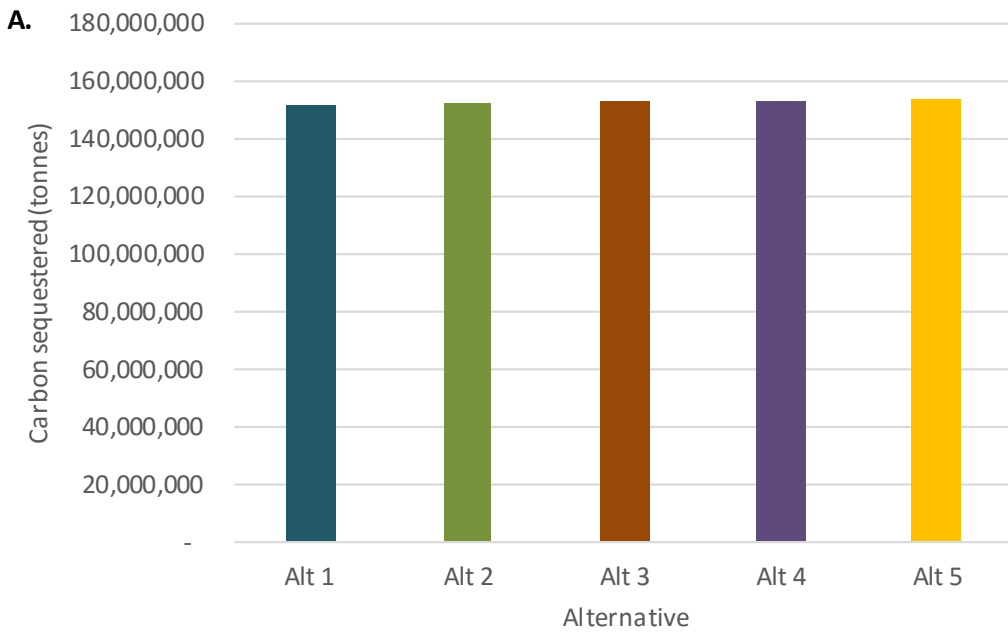


Figure 4.2.2. Total Sequestered Carbon at the End of the Planning Decade 1 (A) and Decade 5 (B)



Impacts to elements of the environment critical to sustainable forest management

VEGETATION

Forest composition

Currently, it is difficult to determine if and how long-term forest productivity will change across DNR-managed lands that may be harvested. For reasons noted in Chapter 3.2, forest productivity will increase or decrease seasonally and annually depending on tree species and location (Littell and others 2008, Peterson and Peterson 2001, Stephenson 1990, 1998). However, broad generalizations about productivity can be made based on current energy and moisture limitations (Milne and others 2002, McKenzie and others 2003, Littell and Peterson 2005). For example, while low-elevation lands in the Puget Trough and the northeast portion of the Olympic Peninsula are more likely to decline in productivity with increasing temperatures and moisture stress, this loss might be offset by increased forest productivity at higher elevations and in 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 productivity likely, habitat goals could be reached sooner or later in different portions of DNR-managed lands, possibly influencing what is harvested and when. Overall, it is not yet possible to conclude when climate-related influences to forest productivity on DNR-managed lands with a regeneration harvest will be positive, negative, or neutral through the life of the HCP. No productivity differences are expected 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 because it may reduce drought-related stress in younger and more moisture-sensitive trees and foster structural and compositional diversity at both the landscape scale (since most of the landscape is young to mid-seral, old forest provides some complement) and at the stand scale (since older forests have the broadest range of tree sizes and species). Thinning will occur in both areas managed for forest cover and areas that are harvested. Alternative 2 maintains the same level of thinning as the no action alternative. Alternatives 3, 4 and 5 result in approximately 88,000–95,000 fewer acres thinned than the no action alternative (Table 4.2.4). However, this is a small difference when considering that DNR manages approximately 1.46 million acres in Western Washington and that some of these areas will be harvested before attaining late-successional conditions. Forest resilience to a changing climate is therefore expected to be similar across the action alternatives and under the action alternatives compared to the no action alternative.

With a changing climate, future regeneration success using the same species and genetic material as presently used may decrease. While it is probable that current seedling stock will be unsuitable for planting at some point in the future, it is also possible different genotypes of the same species from either current or different seed zones will be better adapted. This possibility is greater for Western Washington than many other locations because the primary commercial species currently planted are not yet at the

southern edge of their range. In addition, DNR already uses a broad number of genotypes that have been selected because they perform well across a wide range of environments, and the *Policy for Sustainable Forests* (DNR 2006a) allows for continued species adaptation with climate. Furthermore, given current understanding of seed zones, available methods to inform modified seed zones under future climates (Ying and Yanchuck 2006), and gradual understanding of individual species characteristics (also known as phenology) and genetics (Gould and others 2011, Harrington and Gould 2015, Ford and others 2016), it is possible many planting-related issues can be mitigated in the forthcoming decades. Similarly, silvicultural techniques can be modified to account for changing tree-growing conditions. The potential to dampen climate change effects through planting and silviculture nonetheless requires identifying and filling gaps in scientific understanding. For example, the duration over which current seed sources used in planting will be a reasonable match to future climates is uncertain, nor is it known if the performance of other genotypes from other seed zones will be positive, negative, or neutral relative to past tree growth under the historical climate. It is therefore speculative to infer climatic effects on seedling regeneration success and growth to DNR-managed stands that will be replanted during the life of the HCP. Since planting strategies do not differ across alternatives, any changes to seedling regeneration success and growth are expected to be similar under each alternative.

Table 4.2.4. Acres Thinned Under Each Alternative for Decade 1 and Through Decade 5

Alternative	Thinning acres in Decade 1	Total thinning acres through Decade 5
Alternative 1	56,000	255,000
Alternative 2	43,000	240,000
Alternative 3	31,000	167,000
Alternative 4	32,000	166,000
Alternative 5	21,000	160,000

Alternatives can also be examined more broadly by looking at the area managed for forest cover (Table 4.2.5) From a climate change resistance perspective, there might be an advantage to retaining more lands that will eventually become more structurally complex given habitat goals, uncertainty of disturbance and vegetation trends in specific locations, and the potential loss to forest cover from large stand-replacing wildfires. However, the action alternatives are similar to the no action alternative and similar to each other in the Ecosystem Initiation, Competitive Exclusion, and Structurally Complex stand development stages.

Table 4.2.5. The Total Number of Acres Under Each Alternative Managed for Forest Cover

Alternative	Acres	Difference from Alternative 1	Difference from Alternative 1 as a percent of acres in the analysis area
Alternative 1	726,000	-	-
Alternative 2	716,000	10,000	0.7%
Alternative 3	733,000	-7,000	-0.5%
Alternative 4	740,000	-14,000	-1.0%
Alternative 5	791,000	-65,000	-4.4%

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. 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, wildfires in Western Washington are rarely limited by available fuel; the mild maritime climate largely limits wildfire occurrence in these forests. As such, these forests are therefore both adapted and resilient to stand-replacing disturbance regimes. While these forests have been resilient to stand-replacing disturbances in the past, future resilience to such disturbances becomes less certain with time as the climate changes. Specifically, stand-replacing disturbances will increase exposure of tree seedlings to warmer climates. Because tree seedlings are highly sensitive to temperature and moisture regimes, novel climates could result in regeneration failure of species that have done well in the past and thereby foster unique species assemblages. Mature individuals of long-lived tree species can tolerate unfavorable climate conditions for up to several centuries (Brubaker 1986, Noss 2001). In the absence of stand-replacing wildfire, climate-induced shifts in the composition and distribution of existing forests will therefore likely be muted or substantially lagged (Franklin and others 1991).

Based on the long-term relationship between stand-replacing disturbances and Western Washington forests described in the preceding section, maintaining existing forest cover is a reasonable strategy to promote west-side forest resistance and resilience under a changing climate. Retaining older forested stands would help resist eventual change because older trees are better able to persist through unfavorable conditions created by disturbances than young trees and seedlings. As shown in Table 4.2.6, relative to the no action alternative, there is little difference in total number of acres designated as structurally complex forest (that is, older forest) currently and through the life of the HCP (Decade 5). For example, Alternative 5 increases area of structurally complex forest by 6 percent (an additional 10,000 acres), while there is a 5 percent decline (8,000 acre loss) in this forest condition under Alternative 2 through Decade 5 relative to the no action alternative. Forest resistance to a changing climate is therefore likely to be similar both between the action and no action alternatives and between the action alternatives because acres of structurally complex forest are similar across alternatives in Decade 1 or through Decade 5.

Table 4.2.6. Acres of Structurally Complex Forest Under Each Alternative Currently and at the End of Decade 5

Alternative	Current conditions (acres)	Decade 5 (acres)	Decade 5 difference from Alternative 1 as a percent of acres in the analysis area (percent)
Alternative 1	70,000	168,000	
Alternative 2	70,000	160,000	-5%
Alternative 3	70,000	166,000	-1%
Alternative 4	70,000	170,000	1%
Alternative 5	70,000	178,000	6%

Considering the similarities in total acreage of structurally complex forest, total acres of thinning, and total acres managed for forest cover, minimal differences in impacts to vegetation are expected between

the action alternatives and the no action alternative. There is also little difference between action alternatives.

This conclusion does not mean climate will not impact lands managed for long-term forest cover; only that the differences across all alternatives is sufficiently small that climatic effects will be similar. Furthermore, while this analysis uses the concept of resistance in Western Washington forests, it is recognized that a resistance strategy will eventually fail once a natural stand-replacing disturbance occurs. Without post-disturbance management, species compositions will reflect available seed sources and climate-related seed viability, which may or may not reflect historic composition. In contrast, because managers can select specific species compositions and seed stock, planting following a disturbance (natural or human-caused) can have a greater likelihood to result in stands that resemble past composition.

EARTH

As described in Chapter 3.1, management of potentially unstable slopes and soils will be the same under each of the action alternatives as under the no action alternative. Management of potentially unstable slopes are designed to minimize the impacts of activities and will continue to do so. Any future changes in landslide timing, frequency, or severity due to climate change will be the same under the any of the action alternatives and will likely be similar to future changes under the no action alternative.

AQUATIC RESOURCES

As described in Chapter 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 (refer to the preceding paragraph). These effects of climate change will impact aquatic resources. For the fiscal year 2015–2024 period, the period that the proposal analyzed in the DEIS applies to, climate-related impacts are likely to be low across all alternatives. However, risk to aquatic resources is likely to increase with time. Because streams, wetlands, the surrounding riparian forest areas, and watershed as a whole are managed following the same policies and procedures (refer to Chapter 3.4), little difference in impacts to aquatic resources is expected between the action alternatives and the no action alternative, nor between action alternatives either in the forthcoming decade or through the life of the HCP.

WILDLIFE

As described in Chapter 3.5, wildlife species can be organized into guilds. A guild is a group of species that uses the same class of resources in a similar way. As described in Chapter 3.2, climate change is likely to change disturbance regimes. These changes in disturbance regimes are likely to affect the development of stands and the distribution of different stand development stages, which is likely to affect wildlife. If these changes result in more acres of forest in the Competitive Exclusion stand development stage, the most wildlife guilds (described in Chapter 4.5) would be negatively affected. For the fiscal year 2015–2024 period, the period that the proposal analyzed in the DEIS applies to, climate-related impacts are likely to be low across all alternatives. As the likelihood of disturbances increases with time, risk to forest structure, and therefore habitat, will also increase. But as noted earlier, the timing and location of disturbance events is uncertain and is likely to be similar across alternatives.

From a wildlife species perspective, there is still scientific uncertainty about when climate will directly impact the physiology and life history events of various species. Such disruptions are likely, but when and for which species disruptions will occur is uncertain. Any changes from DNR management is likely to be similar across alternatives.

Potential climate-related impacts on projected harvest levels

Possible changes to forest productivity and composition are described in Chapter 3.2. The effects of these changes on the projected volume estimates are not known and may be positive, negative, or neutral through the life of the HCP. The proposal analyzed in this DEIS is to establish a harvest level for a 10-year period, fiscal year 2015–2024. For the fiscal year 2015–2024 period, climate-related impacts are likely to be low and similar across all alternatives. Projections presented for subsequent decades are less certain due both to uncertainty in any model and due to climate-related changes in growing conditions and disturbances. The risk that projected harvest volumes are incorrect increases as the projections look farther into the future. However, sustainable harvest levels for decades beyond 2024 will be calculated at least once per decade using the best available information at that time.

Based on our current scientific understanding, over the first decade and for the duration of the HCP, the greatest climate-change-related threat to harvest projections is likely from natural disturbances. Natural disturbances may both affect the ability to harvest a projected level directly by reducing harvestable volumes in stands where harvests are planned and indirectly by potentially delaying achievement of a conservation objective that must be met before certain areas can be harvested.

Little difference in the impacts of possible changes to productivity, composition, and disturbance on the harvest level projections is expected between the no action alternative and action alternatives, nor between action alternatives since similar harvest acres are expected in all alternatives.

Table 4.2.7. Summary of Potential Impacts to and from Climate Change

Key questions	Criteria	Measure	Potential impacts
Do any alternatives cause more carbon to be emitted than sequestered?	Net carbon emissions do not exceed net sequestration.	Whether there is a net increase in carbon through time relative to current conditions.	All alternatives are projected to sequester more carbon than is emitted in the next decade and through the life of the HCP.
What effects will climate change have on the action alternatives or their expected environmental impacts?	An increase in risk to elements of the environment key to sustainable forest management.	Whether management approaches reduce climate-related forest resistance and resilience.	Due to relatively small differences in a area of structurally complex forest and in a area available for harvest, no alternative is likely to reduce climate-related forest resistance and resilience under a changing climate.

4.3 Vegetation

This section describes the potential effect of the alternatives on general forest conditions, forest health, and vegetation under special management or conservation status.

Analysis questions

- *Do any alternatives negatively impact forest composition and structure?*
- *Do the alternatives impact gene pool reserves, old-growth forests, rare plants, and rare plant communities?*

Evaluation criteria

Scale of analysis

Vegetation changes, tracked as changes in stand development stage, forest composition, and structure, are analyzed at the planning unit scale. Impacts to rare plants, gene pool reserves, and old-growth forests are discussed across all of Western Washington.

How impacts are measured

Data on forest conditions are used to qualitatively assess composition and structural development on DNR-managed lands in Western Washington. A shift toward less complex stand development stages, such as an increase in the Competitive Exclusion stage, is considered a potential high impact though DNR intends to provide a range of forest condition on trust lands (DNR 2006, p. 47). The impacts of the alternatives on disturbances are assessed qualitatively with increased risk of disturbance considered a potential high impact. The analysis also looks at whether the alternatives would impact rare plants, old-growth stands, natural areas, vegetation on uncommon habitats, and genetic resources. Any impact to these resources is considered a potential high impact.

Summary of direct, indirect, and cumulative impacts

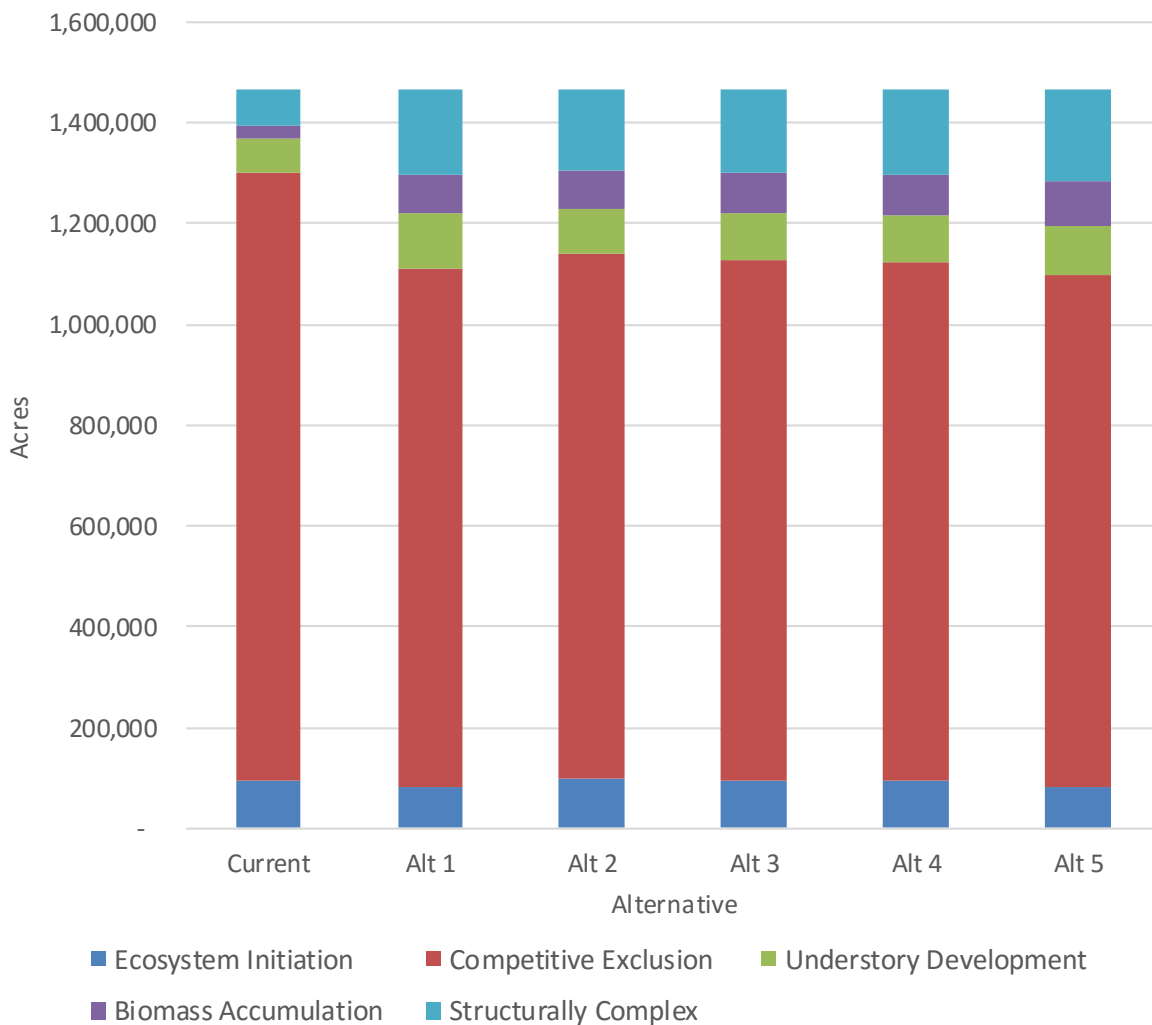
Stand composition and structure

As illustrated in Figure 4.3.1, all alternatives result in similar forest stand conditions based on current DNR policy and management direction, including the 1997 HCP and 2006 *Policy for Sustainable Forests*, and overall forest health on state trust lands is expected to increase over time. All alternatives, including

the no action, result in more forests in the Structurally Complex stand development stage and less forest in the Competitive Exclusion stage, as projected over the next 60 years (Figure 4.3.1).

The increase in Structurally Complex area is expected to result in increased species diversity and greater abundance of understory species, particularly those associated with older forest conditions (Halpern and Spies 1995). The Structurally Complex stands are expected to be located in areas that are deferred from harvest or in areas where variable retention harvest is not generally allowed, such as riparian areas.

Figure 4.3.1. Acres by Stand Development Stage for Current Conditions and Each Alternative at the End of 5 Decades



Forest health

The alternatives do not differ substantially in overall effects on forest health and productivity because the alternatives differ little in projected harvest locations, volumes, and acres as calculated under each alternative (refer to Chapter 2) and because DNR policies regarding forest ecosystem health and productivity will not change. Under all alternatives, DNR will continue to incorporate cost-effective

forest health practices into the management of forested state trust lands to reduce or prevent significant forest resource losses from fire, wind, insects, disease, animals, noxious weeds, and other similar threats to trust assets. DNR will also work closely with the scientific community, other agencies, and other landowners to effectively address forest health issues (per the *Policy for Sustainable Forests*, DNR 2006a).

Information related to forest health and climate change is addressed separately in Sections 3.2. and 4.2.

Vegetation in special management or conservation status

OLD GROWTH

DNR policy generally defers from harvest old-growth stands (stands 5 acres and larger that originated naturally before the year 1850), as well as individual large, structurally unique trees. No significant impact is expected to old-growth stands because they are generally deferred. As with all harvest activity, any activity that included the removal of old-growth stands or individual large, structurally unique trees would be subject to SEPA review.

GENETIC RESOURCES

Gene pool reserves are deferred from harvest in all alternatives. No significant impact is expected to this resource.

RARE PLANTS

Potential impacts to rare plants and plant communities are already part of site-specific assessments conducted for forest management activities. Management of sites containing these species would be consistent with DNR's special ecological features policy (DNR 2006a, p. 39). However, because every location of every rare plant is not known, rare plants can be at risk from forest management activities. Unknown occurrences of rare plants or plant communities will likely get an indirect conservation lift if they are located within a deferred area.

Table 4.3.1. Summary of Potential Impacts on Vegetation

Key questions	Criteria	Measure	Potential impacts
Do any alternatives negatively impact forest composition and structure?	Stand development stages.	Acres of each stand development stage.	No adverse impacts; increase in stands in the Structurally Complex stand development stage and a decrease in stands in the Competitive Exclusion stand development stage.
How do the alternatives impact gene pool reserves, old-growth forests, rare plants, and rare plant communities?	Management changes to gene pool reserves, old-growth forests, rare plants, and rare plant communities.	Policy changes.	No change in policies for gene pool reserves, old-growth forests, rare plants, or rare plant communities.

4.4 Aquatic Resources

Analysis questions

- *How would alternatives affect riparian functions, including riparian habitat, wetlands, water quality and quantity, and fish populations and habitat?*
- *Would any of the alternatives result in impacts to listed fish species in excess of those covered under the 1997 HCP?*

Evaluation criteria

This section considers how proposed changes in harvest volume and associated forest management activities within and adjacent to aquatic resources could potentially alter key aquatic functions using the following criteria:

- Riparian function is maintained. Key indicators of riparian function are large woody debris recruitment; stream shade, which is one of the primary factors influencing stream temperature; leaf and needle litter recruitment, which provides nutrients to streams that support the aquatic food chain; microclimate, which is moderated by tree cover; peak flows, which should not be elevated due to timber harvest activity; and minimized delivery of sediment into streams (DNR 2016a).
- 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 (Chapter 90.48 RCW).
- Riparian function is maintained. The criterion for fish habitat is functioning riparian habitat, with the same functional indicators identified for riparian function.

The analysis also evaluates whether the alternatives would affect DNR's ability to achieve the objectives of the 1997 HCP riparian conservation strategies.

Scale of analysis

This section considers overall trends and effects on aquatic resources at the scale of the sustainable harvest calculation analysis area, which as defined in Chapter 1 as all of DNR-managed forestlands in Western Washington. This analysis scale is used because the proposed action is a non-project action under SEPA and takes place over a large landscape scale; therefore this section cannot consider exactly when and where project-specific forest management activities would occur adjacent to aquatic resources.⁴² Those decisions would be made at a later project-specific (operational) level of planning. This section considers overall trends and effects of the proposed alternatives on aquatic resources at the

⁴² 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, Ch. 4).

scale of the analysis area. The existing riparian conservation strategies and regulatory framework governing water and fish protection remain unchanged under the action alternatives; therefore, measuring impacts at a smaller (for example, watershed) scale is not necessary since those impacts have been addressed in previously published SEPA documents that analyzed the rules and policies governing those activities.

How significance is measured

The significance of aquatic resource impacts is based on the degree to which the key indicators of aquatic functioning would likely be affected by the alternatives. The alternatives differ primarily in the amount of harvest area, so significance is also considered in terms of the proportion of state trust lands that would be disturbed annually, based on the projected acres of annual harvest under each alternative.

Summary of direct, indirect, and cumulative impacts

The proposed alternatives do not change the existing regulatory framework. DNR would continue to implement the riparian conservation strategy objectives of the 1997 HCP, which are designed to achieve long-term and continuous landscape-level restoration of riparian functions over time. However, the marbled murrelet long-term conservation strategy alternatives may affect harvest volumes and change the area available for potential harvest or thinning, and the riparian harvest options would change the level of harvest in riparian areas in the west-side planning units outside the OESF.

Harvest and restoration thinning in riparian areas

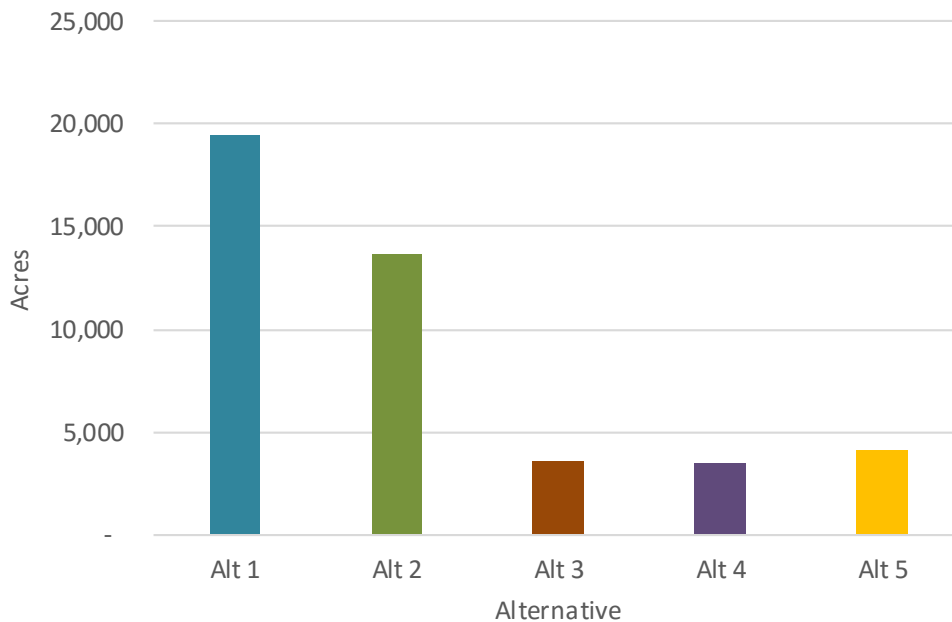
The Riparian Forest Restoration Strategy was established to use thinning as the primary way to hasten the development of riparian stands and restore riparian habitat functions near streams in the five west-side planning units outside the OESF (DNR 2006c, p. 4). Under the Riparian Forest Restoration Strategy, commercial thinning is allowed and even encouraged in riparian areas that are not deferred from timber harvest for other reasons, such as wildlife habitat or steep slopes, when compatible with trust duties. Commercial thinning in forested wetlands and wetland buffers can also occur following procedures designed to maintain wetland function (DNR 2006c).

However, due to operational challenges and high costs of thinning operations, relatively little riparian thinning is projected under any alternative. Alternatives 1 and 2 are expected to result in about four times as much riparian harvest in the first decade as Alternatives 3, 4, and 5. Under Alternatives 1 and 2, less than 2 percent of the total riparian forests would be thinned within the first decade (Figure 4.4.1). Under Alternatives 3, 4, and 5, approximately 0.3 percent of riparian area would be thinned over the first decade.

The relatively small proportion of riparian areas projected to be harvested under all alternatives in the planning period would result in correspondingly low adverse impacts from direct harvest disturbance of riparian areas. However, the low thinning area reduces the opportunity for conducting restoration thinning in riparian areas. The lack of riparian harvest may result in some riparian forest areas remaining in

relatively low-functioning conditions in the Competitive Exclusion stand development stage for many decades (DNR 2006c, p. 5). Due to the low levels of restoration thinning that would occur under all alternatives, opportunities for riparian restoration would not vary significantly among the alternatives.

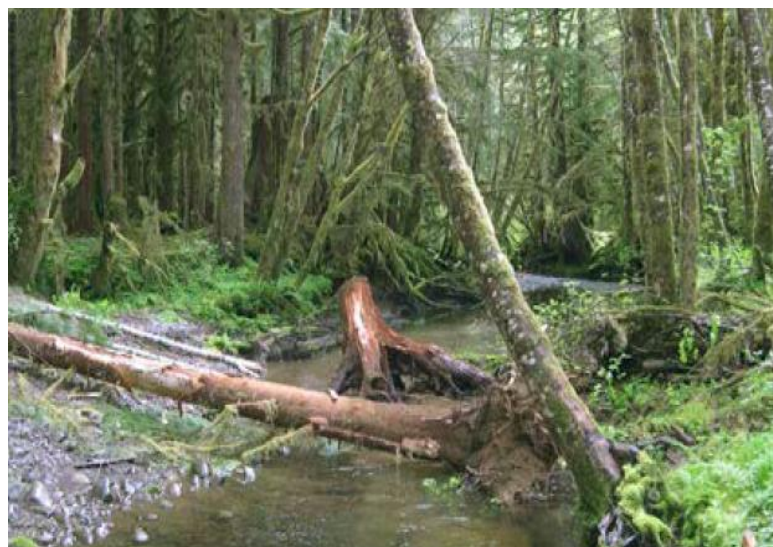
Figure 4.4.1. Acres Thinned in Riparian Areas in the Planning Decade Under Each Alternative



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



Example of large woody debris in a stream

would remain that would continue to provide large woody debris.

Much of DNR's aquatic ecosystems lack the instream large wood debris essential for salmonid habitat, and riparian forests lack the capacity to supply large woody debris in the near future (DNR 2006b, p.6). The reasons for this situation are twofold. First, past forest practices rules provided inadequate protection of riparian forests. As a result, the structurally complex conditions in riparian forests has been greatly reduced on DNR-managed lands. Second, decades ago, instream large woody debris was eliminated from many aquatic ecosystems through practices such as splash damming and clearing of streams for fish passage (Sedell and others 1988).

The 1997 HCP riparian strategies, 2006 Riparian Forest Restoration Strategy, and OESF Forest Land Plan are specifically designed to maintain and aid in restoration of riparian habitat, including promotion of the long-term recovery of large woody debris recruitment potential. Under all alternatives, large woody debris would increase over time from natural growth of wood biomass within riparian buffers in all Western Washington planning units. Alternative 2 allows for slightly more riparian treatments, which will accelerate restoration as compared to Alternative 1. Alternatives 3, 4, and 5 allow for less active management and result in slower progress toward the objective restoring long-term of large woody debris recruitment potential.

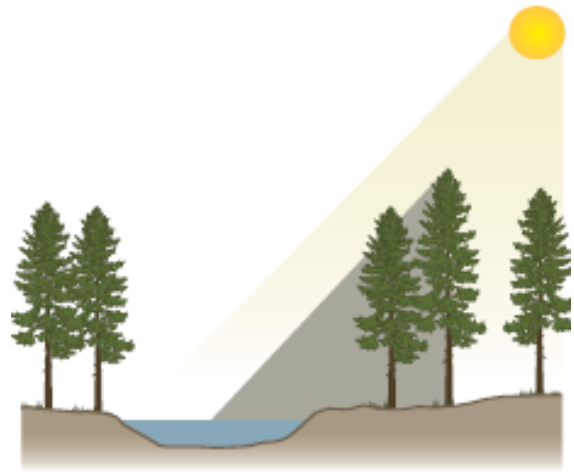
PEAK FLOW

Establishing the sustainable harvest calculation would not alter DNR's existing approach to addressing peak flows, which includes objectives for hydrologic maturity in the rain-on-snow and snow-dominated zones (per PR-14-040-060, *Assessing Hydrologic Maturity*). Under all alternatives, including the no action alternative, DNR must maintain the required area of hydrologically mature forest in all applicable basins. This approach ensures that detectible increases in peak flow are avoided and are consistent with the *Policy for Sustainable Forests*, *Forest Practices Act*, *Washington State Forest Practices Board Manual*, and 1997 HCP. The single basin that currently has below the required amount of hydrologically mature forest will be restored to above the required amount before harvest can occur. This basin is expected reach the required amount of hydrologically mature forest in the 2024–2034 decade.

STREAM SHADE

Figure 4.4.2 Illustration of 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 1997).



Alternative 2 includes approximately 13,700 acres of thinning in riparian forest, which equates to less than 4 percent of the total riparian forests being thinned within a 10-year period. All other alternatives project less than this amount. While thinning of riparian zones would result in temporary reductions in stream shade, the extent of thinning in any one area would be limited and would not be sufficient to significantly increase stream temperatures. In addition, opening up overstocked stands within riparian areas through thinning would help promote more diverse riparian understory vegetation and associated shading and habitat values. Therefore, overall effects of thinning on shading from any of the alternatives would be low.

Stream shade functions of riparian areas would be maintained under all alternatives, as required by the existing riparian management framework which includes the Forest Practices Act, *Washington State Forest Practices Board Manual*, OESF Forest Land Plan, and 1997 HCP.

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 alternatives change existing forest practices rules or DNR procedures regarding road design, maintenance, or abandonment. Therefore, none of the action alternatives is likely to increase fine sediment delivery to wetlands, streams, or any other waters compared to Alternative 1.

Miles of future road management activities are expected to be similar to current miles of activity, with abandonment decreasing to match or be slightly higher than the new construction numbers.

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 account for the majority of nutrient inputs in many small headwater streams and are critically important for the healthy function of these ecosystems (Wallace and others 1997).

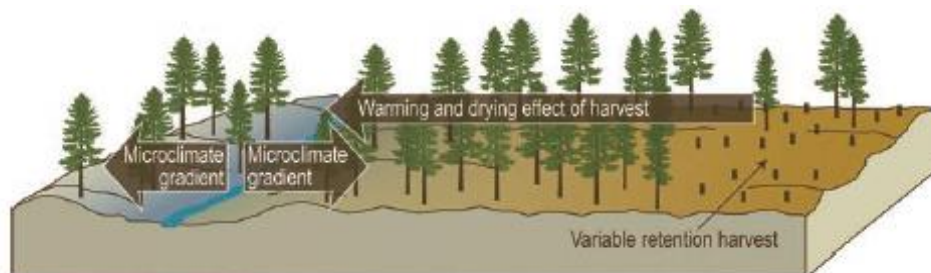
The majority of leaf and needle litter recruitment comes from vegetation growing within 100 feet of a stream (FEMAT 1993), and these zones are protected by the HCP riparian conservation strategies and

forest practice rules. Therefore, none of the alternatives would alter leaf or needle litter recruitment compared to Alternative 1.

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 4.4.3 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 from the stream. In addition, they noted increased relative humidity at distances up to 122 feet from the stream. The heating and drying effects of harvest can extend up to approximately 545 feet into the surrounding unharvested areas (Chen 1991, Chen and others 1995, FEMAT 1993).

Timber harvest may occur well within this 545-foot zone of influence, potentially affecting the microclimate in adjacent areas of riparian forest. However, microclimate is a relatively small component of overall riparian health. Changes in microclimate are not expected to significantly affect riparian habitat.

Effects on Endangered Species Act-listed fish

All alternatives would follow the 1997 HCP, Riparian Forest Restoration Strategy, and associated DNR procedures to protect fish species. As previously evaluated, continued timber harvest in the range of alternatives being considered in this DEIS is not likely to significantly alter the key indicators of aquatic resources or associated habitat values for fish, including bull trout and several species of salmon and steelhead listed as threatened or endangered under the Endangered Species Act. Under all alternatives, habitat for fish species listed under the Endangered Species Act is expected to continue to recover from damages from forest practices conducted on state trust lands prior to the 1997 HCP.

Cumulative effects

Timber harvest from state trust lands continues under all alternatives. The cumulative effects of timber harvest practices on aquatic resources are a major focus of DNR's forest management planning. In addition to the riparian forest management regulations under the Forest Practices Act, the *Washington State Forest Practices Board Manual*, and 1997 HCP, Riparian Forest Restoration Strategy (DNR 2006c), and OESF Forest Land Plan, DNR also implements procedures that address cumulative effects, including PR-14-005-050 Maximum Size for Even-Aged Final Harvest Units and PR-14-040-060 Assessing Hydrologic Maturity. Together, these strategies help DNR minimize the cumulative effects of its timber management activities on aquatic resources.

As part of project-specific environmental reviews under SEPA, DNR also evaluates the cumulative effects of harvests occurring on state and non-state lands over the 7 years preceding any project-specific timber harvest being proposed. These evaluations are conducted at the sub-watershed level and help DNR determine any potential for significant adverse cumulative impacts associated with the harvest so that DNR can avoid, minimize, and mitigate them.

A trend of gradual improvement of riparian functioning and associated aquatic resources is expected to continue over time under all alternatives. The regulatory and policy framework guiding DNR management of riparian areas is designed to maintain and improve the riparian and aquatic conditions. Both the *South Puget Sound HCP Planning Unit Forest Land Plan Final Environmental Impact Statement* (DNR 2010) and the *OESF HCP Planning Unit Forest Land Plan Final Environmental Impact Statement* (DNR 2016a) found gradually improving riparian conditions in and associated with aquatic resources in their respective analysis areas, which are managed under the same regulations and policy framework. Due to this framework, the ongoing timber harvest under any of the alternatives are not likely to significantly alter this overall positive trend and result in an adverse cumulative effect.

Table 4.4.1. Summary of Potential Impacts on Aquatic Resources

Key Questions	Criteria	Measures	Potential Impacts
<p>How would alternatives affect riparian functions, including riparian habitat, wetlands, water quality and quantity, and fish populations and habitat?</p>	<p>No net loss of acreage and function of wetlands (<i>Policy for Sustainable Forests</i>).</p> <p>No net loss of positive indicators of aquatic function.</p> <p>No net gain of negative indicators of riparian function.</p> <p>Other aquatic and riparian obligate species are maintained (1997 HCP, Riparian Forest Restoration Strategy).</p> <p>Functions of riparian and wetland habitat for wildlife and water resources are maintained (1997 HCP).</p>	<p>The degree to which these functions are adequately protected by the existing framework of regulations, policies, and plans.</p> <p>The degree to which the alternatives would change allowable forest management activities.</p>	<p>The existing framework of regulations, policies, and plans adequately address most potential effects on aquatic resources.</p> <p>Low level of thinning in riparian areas may slow progress toward riparian restoration goals established in the Riparian Forest Restoration Strategy.</p>
<p>Would any of the alternatives result in impacts on listed fish species in excess of those covered under the 1997 HCP?</p>	<p>Functioning riparian habitat; same criteria as in previous row.</p>	<p>Same as in previous row.</p>	<p>Continued timber harvest is not likely to significantly alter the key indicators of aquatic resources or associated habitat values for fish.</p>

4.5 Wildlife and Biodiversity

This section considers the effects of sustainable harvest calculation alternatives on wildlife.

Analysis questions

- *How will the level of harvest allowed under each action alternative impact populations of federally listed wildlife species?*
- *How will each alternative affect wildlife habitat?*



DNR-managed lands in South Puget planning unit

Evaluation criteria

This analysis considers the following criteria for determining whether the *Policy for Sustainable Forests* and the 1997 HCP are maintained under the alternatives:

- Northern spotted owl habitat targets and conservation strategies are maintained.
- Species listed as threatened or endangered since the 1997 HCP are not experiencing adverse impacts.
- Wildlife habitat and species diversity and the ecological functions needed to support them on DNR-managed lands in Western Washington are maintained.

Scale of analysis

For this DEIS, effects on listed species and biodiversity are considered in terms of trends over the entire analysis area for a 5-decade period.

How significance is measured

Significance is based on the degree to which alternatives would comply with the 1997 HCP and the *Policy for Sustainable Forests*. For listed species, significance is also based on the degree to which the alternatives may interfere with species recovery and the ability of the species to breed, feed, or seek shelter.

The significance of wildlife habitat changes due to timber harvest is based on the change in amount of each forest stand development stage over time, as projected by the forest state model for each alternative. This model uses stand age to estimate stand development stage.

■ Summary of direct, indirect, and cumulative impacts

Northern spotted owl

HABITAT IN SPOTTED OWL MANAGEMENT UNITS

Spotted owl habitat within the OESF, designated spotted owl dispersal management areas, and nesting, roosting, and foraging management areas would not be harvested under any of the alternatives until threshold targets established by the 1997 HCP are met (DNR 2007). Harvest of spotted owl habitat may occur in the few spotted owl management units that are above threshold. All of these spotted owl management units above threshold are dispersal management areas. Any harvest of spotted owl habitat would be associated with a timber sale that would include a thorough site-specific review, including a SEPA checklist.

SETTLEMENT AGREEMENT

None of the alternatives would change the way DNR manages or protects spotted owl habitat under the 1997 HCP.

Under the action alternatives, the 2006 Settlement Agreement would terminate, resulting in potential harvest in low-quality spotted owl habitat (sub-mature habitat or young forest marginal habitat, refer to Appendix A in DNR 2016d for a description of spotted owl habitat classifications used by DNR). None of these lands are considered critical to DNR's HCP conservation strategy for spotted owl to provide demographic support to the *USFWS Northern Spotted Owl Recovery Plan* (USFWS 2011).

The total area of habitat subject to the Settlement Agreement is about 5,000 acres. Most of this habitat is in small, isolated patches (average patch size is 25 acres) not continuous with federal lands or DNR nesting, roosting, and foraging management areas in the five west-side HCP planning units. None of the acres are located in the OESF. Some of this habitat is in areas that will not be harvested due to other policies and laws. The area that may be harvested depends on the alternative (Table 4.5.1). Impacts due to harvest of these areas are speculative and cannot be quantified, but due to the small patch size, isolation of the patches, and low-quality of the habitat, is unlikely to interfere with spotted owl recovery.

Table 4.5.1. Area of Northern Spotted Owl Habitat Subject to the Settlement Agreement Available for Harvest in Each Alternative

Alternative	HCP planning units					Total
	Columbia	North Puget	South Coast	South Puget	Straits	
Alternative 1	0 acres – Settlement Agreement is retained in this alternative					
Alternative 2	260 acres	2 acres	1,454 acres	1 acres	951 acres	2,669 acres
Alternative 3	260 acres	1 acres	1,433 acres	1 acres	840 acres	2,535 acres
Alternative 4	259 acres	1 acres	1,432 acres	1 acres	767 acres	2,460 acres
Alternative 5	193 acres	0 acres	989 acres	0 acres	911 acres	2,094 acres

No acres of northern spotted owl habitat subject to this this aspect of the Settlement Agreement are in the OESF HCP planning unit.

ENHANCEMENT THINNING

The Settlement Agreement results in Alternative 1 including more thinning in the OESF than the action alternatives. However, under the action alternatives, DNR would continue treatments where needed to reach spotted owl habitat thresholds and allow harvest as described in the OESF Forest Land Plan. Since habitat enhancement activities would continue to occur, the deduction of thinning acres in the action alternatives have no effect on the spotted owl.

CONTINUED INCREASE IN HABITAT WITHIN DESIGNATED AREAS

The area of northern spotted owl habitat on DNR-managed lands will continue to increase over time under all alternatives as habitat continues to develop within designated spotted owl management units and OESF landscapes.

Impacts on northern spotted owl in the context of barred owls

The 1997 HCP was completed at a time when federal and state land managers were expecting spotted owl populations to stabilize due to the *Northwest Forest Plan* (DNR 1998). However, as considered in both the 2004 sustainable harvest calculation (DNR 2004) and the 2007 Addendum (DNR 2007), northern spotted owl populations are still in decline (Buchanan 2016). Competition and predation by barred owls is believed to be a major cause of this decline (Buchanan 2016, Davis and others 2016).

Based on the wide-ranging nature of declines in northern spotted owl populations—even within National Parks and National Forest lands where relatively large blocks of old-growth habitat have been retained—it is likely that the factors driving the decline are not specific to DNR-managed lands. The overall strategy taken by DNR and the USFWS under the 1997 HCP was to focus spotted owl conservation in areas most important to spotted owl conservation by protecting clusters of spotted owls that occur largely on federal reserves (DNR 1997, p. IV-3). DNR managed lands in the OESF and in nesting, rooting, and foraging and dispersal management areas to provide either demographic support, maintain species distribution, or allow for dispersal. The continued decline of spotted owls does not seem to undermine this overall conservation strategy. With the continued threat of barred owls, providing support to large core areas that

support clusters of active spotted owl territories are still likely to be the highest spotted owl management priority for state trust lands.

Other threatened and endangered species

GRAY WOLF

No alternative changes the management of gray wolf. Under the 1997 HCP, all harvests and road-building comply with forest practices rules and state wildlife regulations. These activities are not expected to significantly interfere with the recovery of gray wolf.

GRIZZLY BEAR

Timber harvest on the eastern portions of state trust lands within the North Puget and South Puget planning units could potentially affect potential grizzly habitat suitability by increasing human activities. However, because grizzly occur primarily in roadless, alpine and subalpine areas (USFWS, 1997b) and because state trust lands primarily have roads and are located below subalpine forests, continued timber harvest on state trust lands is not likely to significantly interfere with the recovery of grizzly populations within the North Cascades ecosystem, a designated recovery area.

NON-FOREST OPENING AND WETLAND SPECIES

Columbian white-tailed deer, streaked horned lark, Oregon spotted frog, Oregon silverspot butterfly, and Taylor's checkerspot butterfly occur in non-forest openings or wetland areas and rarely, if ever, occur within the forests managed for timber harvest that are subject to the sustainable harvest calculation. Impacts on these species are not expected to be significant and would be addressed as part of project-specific planning and SEPA review.

Wildlife habitat and species diversity

DECLINE IN COMPETITIVE EXCLUSION AND INCREASE IN STRUCTURALLY COMPLEX FOREST

As documented in Section 3.3, Vegetation, all alternatives result in very similar forest stand composition and structure over time (refer to Figure 4.1.1). Forest in the Competitive Exclusion stage is the most abundant habitat type on forested trust lands and would remain so under all alternatives.

The Competitive Exclusion stage tends to have lower species diversity and less abundant understory vegetation than later stages (Halpern and Spies 1995, Johnson and O'Neil 2001). The majority of timber harvest is also expected to occur in this stand development stage under all alternatives and throughout the 5-decade analysis period.

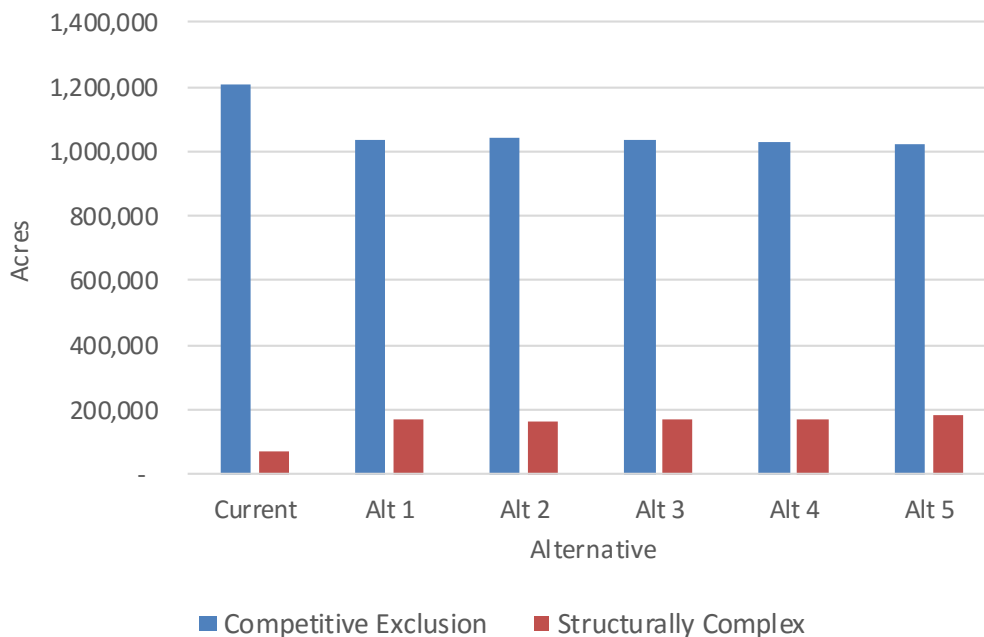
Under any of the alternatives, wildlife habitat areas and distributions on state trust lands would follow very similar trends. The Competitive Exclusion stage would continue to be the dominant stand

development stage, but the number of stands in this stage would decrease over time. The area of forest in the Competitive Exclusion stage would gradually reduce over time through two processes: conversion to ecosystem initiation forest through high-volume timber harvest, and—on lands deferred from timber harvest for marbled murrelet or other reasons—development into structurally complex forest through natural forest succession and forest management activities such as thinning.

All alternatives would reduce the amount of Competitive Exclusion stands on DNR-managed lands in Western Washington (Figure 4.5.1). For the most part, decreases in the amount of competitive exclusion forest correspond to increases in the amount of structurally complex forest (Figure 4.5.1). The increase in area of structurally complex forest is expected to result in increased species diversity, particularly for late successional guild species such as northern goshawk, northern pygmy owl, brown creeper, Vaux’s swift, Townsend’s warbler, red tree vole, black bear (for denning), and northern flying squirrel (based on Johnson and O’Neil 2001).

Populations of non-listed species that are important for recreational, economic, cultural, and ecological values—including hawks, deer, elk, bear, cougar, and forest grouse—are expected to be maintained throughout state trust lands as all alternatives would result in a similar mosaic of habitat types. The moderate reduction of competitive exclusion forests and increase in structurally complex forests are likely to moderately benefit these species over time.

Figure 4.5.1. Changes in Competitive Exclusion and Structurally Complex Forests for Current Conditions and Under Each Alternative at the End of 5 Decades



Timber harvest would continue to create Ecosystem Initiation stands, edge habitat, and associated high wildlife use. On lands where variable retention harvest is allowed, forest stands would, over decades, cycle between Ecosystem Initiation and Competitive Exclusion, never reaching Structurally Complex stages. These lands would still provide habitat for the many species of wildlife associated with the Ecosystem Initiation stage and edges. While Competitive Exclusion stands make a relatively small

contribution to biodiversity, they still contain features important to supporting wildlife diversity, including legacy trees and tree patches, riparian and wetland areas, and non-forest habitat types such as talus and balds.

All alternatives are expected to increase overall wildlife habitat and species diversity across DNR-managed lands, as habitat both within and outside of deferred areas 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 wildlife habitat and biodiversity within the working forest landscape (DNR 2016a, p. 3.25).

OTHER FOREST MANAGEMENT ACTIVITIES: ROADS, ACCESS, TRAFFIC, RECREATION

The alternatives may result in minor adjustments to road management. However, none of the alternatives are expected to alter road densities or locations to the point that the diversity of wildlife habitats or species is affected.

Sensitive and regionally important wildlife

None of the alternatives are likely to affect populations of species listed in Table 4.5.2 at the landscape level. The increase in structurally complex forests projected under all alternatives would potentially increase breeding, resting, and hiding habitat for several sensitive species.

Table 4.5.2. Potential Impacts to Wildlife

Key questions	Criteria	Measures	Potential impacts
<p>How will the level of harvest allowed by each alternative impact populations of listed wildlife species?</p>	<p>Northern spotted owl habitat targets and conservation strategies are maintained.</p> <p>Species listed as threatened or endangered since the 1997 HCP was approved are not adversely affected.</p>	<p>Degree to which alternatives would comply with applicable policies and plans, including the 1997 HCP.</p> <p>Effect of alternatives on key habitat components important to breeding, feeding, and seeking shelter.</p>	<p>None of the alternatives would change DNR management prescriptions for listed species.</p> <p>Timber harvest may have local effects on the distribution and habitat use of gray wolf and grizzly bear, but no significant effects on these species or their recovery is likely.</p>
<p>How will the alternatives affect wildlife habitat?</p>	<p>Wildlife habitat and species diversity on DNR-managed lands are maintained.</p>	<p>Changes in the amount of forest in Competitive Exclusion and Structurally Complex stand development stages over time.</p>	<p>All alternatives will result in decreases in low-value competitive exclusion habitats and increases in high-value structurally complex forests, resulting in a net benefit to wildlife habitats and diversity over time.</p>

4.6 Marbled Murrelet

Impacts to marbled murrelet resulting from different configurations and quantities of marbled murrelet long-term forest cover are analyzed in Chapter 4.6 of the marbled murrelet long-term conservation strategy DEIS. This DEIS incorporates the analysis by reference. The sustainable harvest calculation alternatives incorporate long-term forest cover from five of the six marbled murrelet long-term conservation strategy alternatives. The marbled murrelet long-term conservation strategy alternative that is not included in the sustainable harvest calculation alternatives, Alternative C, has an area of long-term forest cover similar to two other alternatives (Alternatives D and E) and would result in similar harvest levels. The impacts from Alternative C are expected to be similar to Alternatives D and E. In addition, the total harvest level would be within the range of levels analyzed in this DEIS.

The analysis in the marbled murrelet long-term conservation strategy DEIS assumes harvest levels outside of long-term forest cover will remain similar to past harvest levels. Since 2005, between 432 and 654 MMBF have been sold from DNR-managed lands in Western Washington each year. All the sustainable harvest calculation alternatives result in harvest levels within this range.

Portions of Western Washington included in the sustainable harvest calculation analysis area but outside of the marbled murrelet analysis area are not expected to support marbled murrelet because they are beyond the 55-mile inland range of the marbled murrelet. Therefore no additional analysis of impacts to the marbled murrelet is necessary.

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