Chapter 4

Cumulative Impacts and Uncertainties

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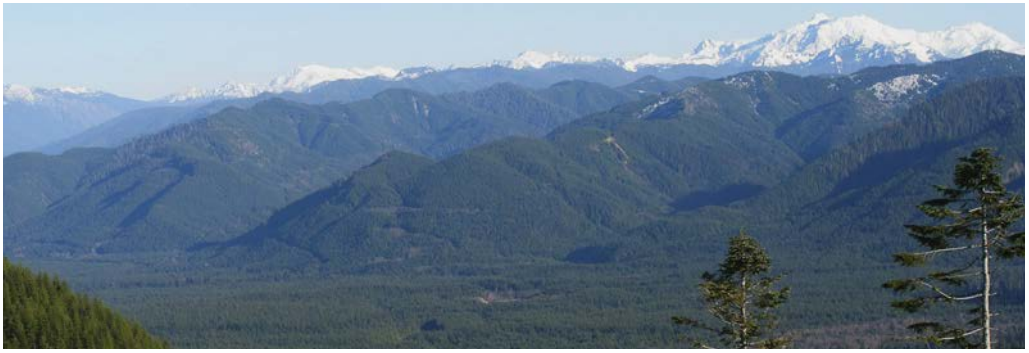


In this chapter, DNR considers the potential environmental impacts of the alternatives (No Action and Landscape) in the context of impacts from past, present, and reasonably foreseeable future activities on lands in the OESF managed by other landowners (federal and private). DNR also provides a brief overview of the uncertainties in the analysis.

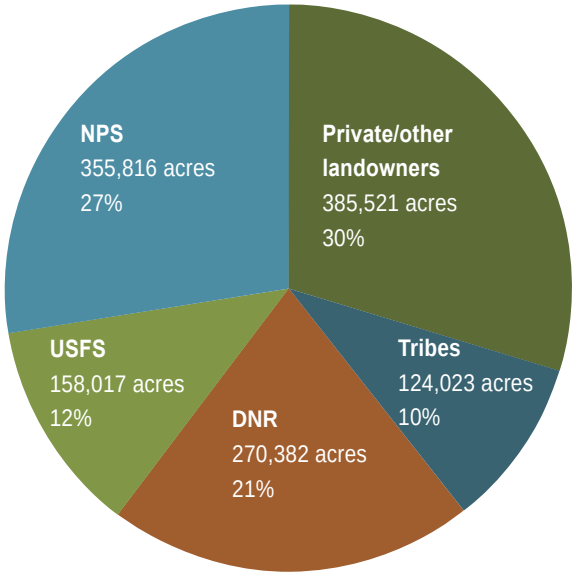
Introduction

As explained in Chapter 1, the OESF boundaries encompass lands managed by DNR as well as USFS, NPS, private landowners (including timber companies), tribes, and others. DNR manages 21 percent, or 270,382 acres, of the approximately 1.3 million acres of the OESF. Chart 4-1 (also presented as Chart 1-1 in Chapter 1) shows land ownership in the OESF. In this RDEIS, the term "OESF" refers to the entire planning area, including lands owned and managed by other landowners.

For this cumulative impact assessment, DNR considers the potential environmental impacts of the alternatives (No Action and Landscape) in the context of impacts from past, present, and reasonably foreseeable future activities on lands in the OESF managed by other landowners (federal and private). This assessment provides a more complete understanding of current conditions and insight into the possible future condition of the OESF.

Assumptions about current and future activities on federal and private lands are based on current

Chart 4-1. Land Ownership in the OESF



management policies and laws and past actions. This analysis uses DNR forest inventory data and USFS inventory data produced by Ohmann and Gregory (2002).

Past Impacts

Most DNR-managed lands in the OESF (266,870 acres) are state trust lands (the remaining 3,512 acres of DNR-managed land are natural resource conservation areas and natural area preserves).[1] As explained in Chapter 1, state trust lands are held as fiduciary trusts to provide revenue for specific trust beneficiaries. (For a complete description of DNR's trust management duties, refer to 2006 *Policy for Sustainable Forests*, p. 9 through 16.) DNR provides revenue primarily through the harvesting of timber.

Lands owned and managed by the federal government include Olympic National Park and Olympic National Forest. Olympic National Park, managed by NPS, was established in 1938. Nearly 96 percent of the park was designated as wilderness in 1988. Olympic National Forest, managed by USFS, was established as the Olympic Forest Reserve in 1897 and renamed Olympic National Forest in 1907.

Most of Olympic National Park has not been harvested, but outside the park, most areas have been harvested intensively. Timber harvest operations on the Olympic Peninsula began in the late 1800s when the harvested timber was hauled out by trains. The extent of harvesting at that time was limited by difficult terrain that trains could not navigate. Timber harvesting increased substantially with the advent of the logging truck in the 1920s and the completion of a loop road that encircled the Olympic Peninsula (present-day US Highway 101) in the 1930s (Evans and Comp 1983). Harvest of older forests accelerated between 1949 and 1970, with most harvest taking place in old-growth forests (USFWS 1997). This harvest of old-growth forests resulted in a loss of habitat for a number of native species, including marbled murrelets and northern spotted owls. In October 1962,

the Columbus Day storm caused large-scale windthrow on the western Olympic Peninsula, which drove a significant salvage logging effort requiring an extension of the road network.

The harvest of older forests declined dramatically in the late 1980s and early 1990s following the listing of the marbled murrelet and northern spotted owl as threatened species under the Endangered Species Act and the adoption of the federal *Northwest Forest Plan* (formally named the 1994 *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl*).

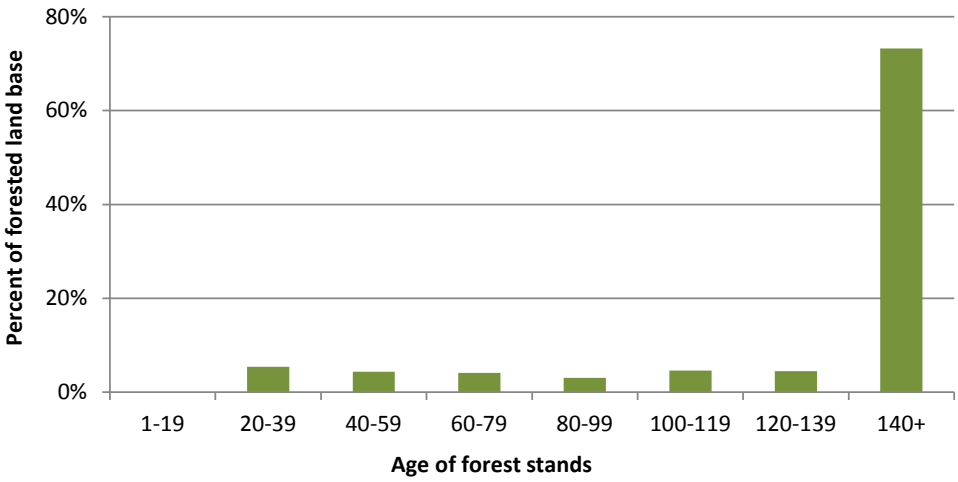
Present Impacts

Olympic National Park

Chart 4-2 shows the age class distribution of forest stands on the portion of Olympic National Park managed by NPS and located inside the OESF boundaries (an age class distribution shows the distribution of forest stand ages in classes or categories such as age 0 through 19 and 20 through 39). Most of this area consists of forest stands that are 140 years old or older (gradient nearest neighbor [GNN] data set 2012). It is possible that many of these older stands contain multiple canopy layers, down wood, snags, and other structural features that would put them in the Structurally Complex stand development stage. However, stand age alone is not enough to estimate the development stage of these stands.

Older, structurally complex forest stands provide a wealth of biodiversity (Franklin 1993). These stands are considered capable of providing high quality habitat for numerous wildlife species, including northern spotted owls and marbled murrelets. (For a discussion of wildlife associated with all of the stand development stages, refer to "Wildlife," p. 3-182.)

Chart 4-2. Olympic National Park Forest Stand Age Class Distribution[a]

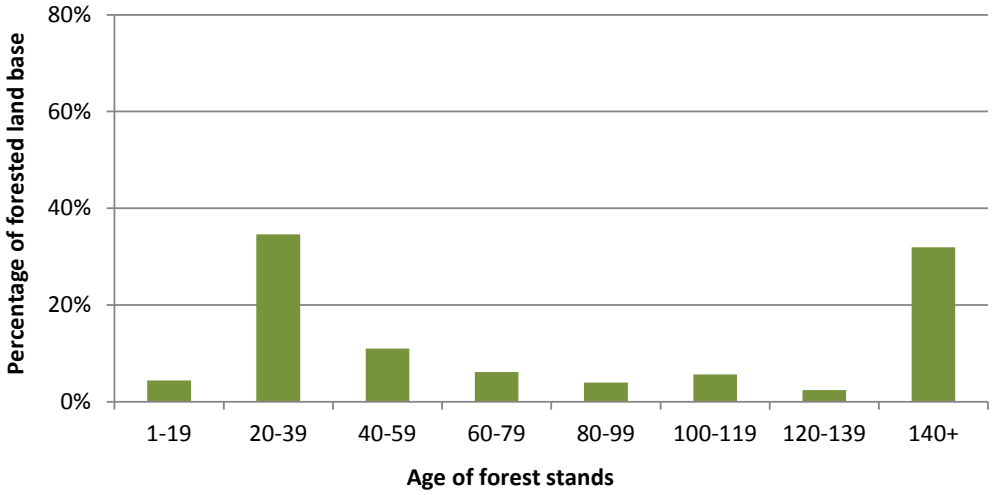


[a] Data Source: DNR Parcels, NDMPL, GNN (DOM_AGE) compiled in 2012 by DNR; age class 1-19 has 2,415 acres (too few to show at this scale)

Olympic National Forest

Chart 4-3 shows the age class distribution of stands in the portion of the Olympic National Forest managed by USFS and located inside OESF boundaries. In these areas, all age classes are present, with a fairly equal proportion of younger stands (20 to 39 years old) and older stands (140 years old and older). This age class distribution most likely is due to past timber harvests.

Chart 4-3. Olympic National Forest Stand Age Class Distribution[a]

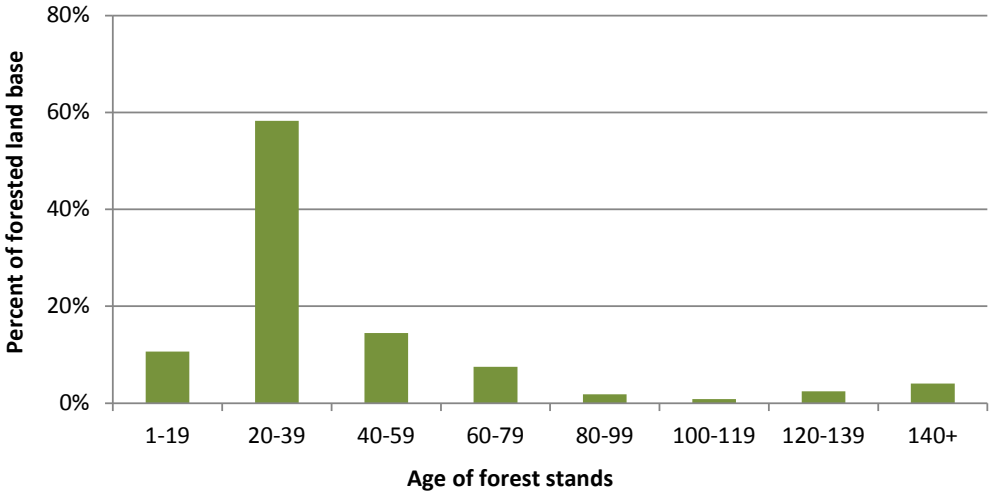


[a] Data Source: DNR Parcels, NDMPL, GNN (DOM_AGE); compiled by DNR in 2012

Lands Managed by Private and Other Landowners

Lands in the OESF managed by private and other landowners (excluding state trust lands) are dominated by younger forests (20-39 years in age). Most likely, this age class distribution is the result of past timber harvests (refer to Chart 4-4).

Chart 4-4. Private/Other Forest Stand Age Class Distribution[a]

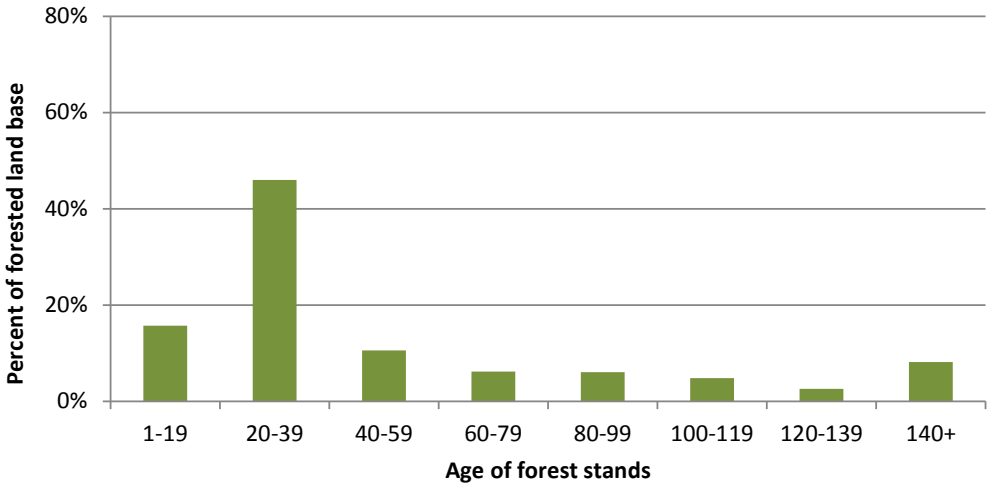


[a] Data Source: DNR Parcels, NDMPL, GNN (DOM_AGE); compiled by DNR in 2012

State Trust Lands

Lands in the OESF managed by DNR are dominated by younger forests (20-39 years in age). Most likely, this age distribution is the result of past timber harvests (refer to Chart 4-5).

Chart 4-5. State Trust Lands Forest Stand Age Class Distribution



All Ownerships: Water Quality

All categories of landowners within the OESF have waters identified on the 303(d) list[2] as not meeting water quality standards for a variety of indicators. (For the stream miles that exceed standards for each landowner, refer to Appendix C.) For all landowners, the most common causes of a stream not meeting water quality standards are elevated water temperature, followed by reduced levels of dissolved oxygen,[3] both most likely attributable to reductions in stream shade. Both state and private landowners have waters listed on the 303(d) list for turbidity (water cloudiness). Turbidity may be caused by fine sediment washing into streams from the road network.

Future Impacts

Future Impacts on Federal and Private Lands

Based on current land ownership (refer to Chart 4-1), timber harvesting is expected to continue being the primary land use in the OESF. For that reason, in this RDEIS, DNR does not discuss potential impacts from other industries, such as mining or agriculture.

Olympic National Park was designated to preserve a sample of primeval forest, provide habitat for a variety of wildlife species, and provide recreational access to mountains, glaciers, forest, and the wild coastline (NPS 2010). Harvest activities are not anticipated on park lands.

Olympic National Forest is managed according to the 1990 Olympic National Forest Land and Resource Management Plan as amended by the 1994 Northwest Forest Plan. Most of the forest has been placed in one of three land classifications:

- **Late Successional Reserves**: These areas are set aside to protect current old-growth and late successional (older, mature) forests and to develop future old-growth forests. These areas provide habitat for wildlife species associated with mature and old-growth ecosystems, including the northern spotted owl. Forest management activities in these areas are designed to maintain or enhance habitat for wildlife species related to late successional and old-growth forests.
- **Adaptive Management Areas**: In these areas, USFS develops and tests innovative approaches for integrating economic and ecological goals.
- **Riparian Reserves**: These areas are set aside to protect the health of aquatic systems and the species that depend on them, and to provide incidental benefits to upland species. Forest management activities in these areas are designed to protect and enhance watershed and aquatic habitat conditions (USFS 2012).

Based on the objectives for each land classification, DNR anticipates that most harvest activities in the Olympic National Forest will consist of thinning (USFS 2013).

Both Olympic National Park and Olympic National Forest are managed to maintain and restore habitat conditions necessary to support viable populations of northern spotted owls (Davis and others 2011). DNR assumed that habitat for northern spotted owls will increase on federal lands in the long term (USDA and USDOI 1994, Davis and others 2011).

For this analysis, DNR does not expect management of private lands in the OESF to change from current practices. Private landowners conduct timber harvest activities according to forest practices rules. The rules provide guidance for timber harvest, reforestation, road construction, and other harvest-related activities. For example, riparian areas on private lands will be protected by buffers as required by the rules currently in place and as amended.

The forest practices rules identify critical habitat for both northern spotted owls and marbled murrelets in Washington (WAC 222-16-080), including on private land. The management of northern spotted owl and/or marbled murrelet habitat on private lands is affected by the amount of land a landowner owns, the presence of suitable habitat on those lands, and any agreements a landowner has with WDFW and/or USFWS (WAC 222-16-080; WAC 222-16-100). In general, the forest practices rules restrict the amount of harvest and the timing of harvest activities in the vicinity of northern spotted owl circles and suitable marbled murrelet nesting habitat (WAC 222-16-080). Additional restrictions apply to lands located within areas designated as spotted owl special emphasis areas (WAC 222-10-041; WAC 222-16-080; WAC 222-16-086).

The forest practice rules primarily protect existing habitat and do not address the development of new habitat. The northern spotted owl recovery plan includes recovery actions for private landowners (USFWS 2011), but these actions are voluntary. Therefore, the contribution of private lands to the development of new habitat may be limited.

Roads

Impacts to water quality from roads on national forest lands in the OESF are expected to decrease in the future. In November 2000, managers of national forests within Washington, including the Olympic National Forest, signed a forest management agreement with Ecology about repairing, maintaining, and closing federal forest roads to help protect water quality. To implement this agreement, USFS agreed to develop road maintenance and abandonment plans for all federal forest roads in Washington and to implement them within 15 years (Ecology 2000). In 2008, Congress authorized funding of the legacy roads and trails program, which is intended to reduce risks and impacts to watershed health and aquatic ecosystems by removing fish passage barriers, decommissioning unneeded roads, and addressing critical repairs and deferred maintenance (USFS 2009). By the end of fiscal year 2010, under this program, 42 miles of road in Washington had been decommissioned and 788 miles of road had been storm-proofed (USFS 2011).

All private large forest landowners[4] are under the same obligation as DNR to prepare and implement road maintenance and abandonment plans. Small private forest landowners[5] are required only to submit a road maintenance and abandonment plan checklist when they file a forest practices application, unless DNR determines that a road on a small parcel of forestland will, or is likely to, cause significant damage to a public resource such as a stream. In this case, a full road maintenance and abandonment plan, which includes a compliance schedule, is required. Full or partial funding for removing fish passage barriers is available to private owners of small parcels of forestland through the family forest fish passage program (WAC 222-24). DNR anticipates that road improvements will continue to be made on private lands.

Future Impacts on State Trust Lands

As described in Chapter 2, the OESF will be managed under integrated management. Integrated management is an experimental management approach based on the principal that a forested area can be managed to provide both revenue production (primarily through the harvesting of trees) and ecological values (such as biodiversity) across its width and breadth. **The outcome of integrated management should be a functioning, healthy, productive forest ecosystem that provides both quality timber for harvest and habitat for native species across state trust lands**. Both of DNR's alternatives implement integrated management. (For descriptions of integrated management and DNR's two alternatives (No Action and Landscape), refer to Chapter 2).

Chapter 3 of this RDEIS examines potential, future impacts to state trust lands that may result from implementing either of the alternatives. DNR analyzed eight topics: forest conditions and management, riparian, soils, water quality, fish, wildlife, northern spotted owls, and climate change.

To analyze each topic, DNR uses criteria and indicators. Criteria are broad concepts, such as forest health or functioning riparian habitat. Indicators are the specific, quantitative means by which the criteria are measured. For example, the indicator stand density (crowding of forest stands) is used to measure the criterion forest health, and the indicator stream shade is used to measure the criterion functioning riparian habitat.

DNR uses a two-step process to identify impacts. In step one, DNR quantifies potential environmental impacts for each indicator as low, medium, or high using parameters defined for each indicator. In this analysis, only potential high impacts are considered potentially significant impacts. In step two, DNR considers the full range of its current management practices to identify particular programs, rules, procedures, or other measures that are expected to mitigate the impact to a level of non-significance. Potential high impacts that will be mitigated are not considered probable significant adverse. DNR may also determine if a potential high impact is significant based on factors such as the role the indicator plays in ecological function. A complete explanation of DNR's analysis methodology can be found in the introduction to Chapter 3 (p. 3-11).

If a potential high impact will not be mitigated through current management practices, and the indicator plays an important role in ecological function, the potential high impact is considered probable significant adverse. For these indicators, DNR describes possible mitigation. Unlike current management practices, possible mitigation is something that DNR may do to reduce a potential high impact to a lower level, but is not committed to implementing at this time. It is suggested, not required.

According to DNR's analysis, potential environmental impacts for most indicators are low or medium. In fact, some potential low impacts represent a general improvement in conditions. Over the 100-year analysis period, DNR's projections have shown the following:

- An **increase in the number of acres of state trust lands in the Structurally Complex stand development stage**. DNR considers an increase in structural complexity a benefit to wildlife (refer to "Wildlife," p. 3-187). Developing and maintaining structural complexity in managed stands is important to any forest management program that intends to maintain forest biodiversity and ecosystem processes (Lindenmayer and Franklin 2002).

- A **decrease in the number of acres in the Competitive Exclusion stage**. No wildlife species in Western Washington are found exclusively in the Competitive Exclusion stand development stage (Carey and Johnson 1995) because of the low structural diversity and low or absent shrub cover in this stage (Johnson and O'Neil 2001).

- A **reduction in the number of acres of state trust lands considered to be in a high forest health risk category** because of overstocking (too many trees). Although not universally true, trees with less room to grow are less able to withstand attack from insects, pathogens, and parasites (Safranyik and others 1998).

- A **gradual improvement in riparian conditions**, as demonstrated by improvements in the composite watershed scores. The composite watershed score assesses the health of the riparian system as a whole.

- An **increase in the number of acres of northern spotted owl habitat**.

Potential high impacts are identified for only a few indicators. Most of these impacts are related to the potential delivery of fine sediment from the road network (potential road failure, road density, proximity of roads to streams, and fine sediment delivery from the

road network to certain types of fish habitat). These potential high impacts are identified based on the mapped extent and location of the road network, without considering the condition of the road network or current management practices (established programs, rules, procedures, or other practices) that are expected to mitigate a potential high impact to a level of non-significance. Mitigation is not considered until the second step in DNR's analysis process, when DNR determines if potential high impacts are probable significant adverse. **All potential high impacts related to the road network are expected to be mitigated to a level of non-significance through current management practices, which include implementing road maintenance and abandonment plans; inspecting, maintaining, and repairing roads; and suspending timber hauling during storm events**.

In this RDEIS analysis, DNR identified only one potential significant adverse impact. DNR's analysis found that more than 10 percent of essential coho salmon winter rearing habitat is projected to remain in a high impact condition for large woody debris recruitment during most decades of the analysis period. This impact will not be mitigated through current practices. However, DNR has identified possible mitigation; refer to "Fish," p. 3-177 for more information.

Conclusion

As stated previously in this section, DNR considers the potential environmental impacts of the alternatives in the context of the impacts from past, present, and reasonably foreseeable future activities on lands in the OESF managed by other landowners (federal and private). Based on this analysis, DNR anticipates the following for the 100-year analysis period:

- **Federal landowners**: Thirty-nine percent of the OESF is managed by federal agencies. Olympic National Park is managed by NPS primarily to maintain natural ecosystems and processes; Olympic National Forest is managed by USFS to maintain or enhance habitat for late successional and species related to old-growth forests, and to protect and enhance watershed and aquatic habitat conditions. Conditions on federal lands are expected to continue improving.
- **Private landowners**: Thirty percent of the OESF is managed by private landowners, including timber companies, who manage their lands according to the forest practices rules. Environmental conditions on private lands are generally expected to improve.
- **DNR**: Twenty-one percent of the OESF is managed by DNR for both revenue production and ecosystem values through an integrated management approach. As demonstrated in this RDEIS analysis, over the 100-year analysis period, DNR anticipates a general improvement in conditions.

In conclusion, DNR anticipates that conditions across ownerships will continue improving over the 100-year analysis period. Implementation of the proposed forest land plan for the OESF is expected to further improve this trend: as DNR implements integrated management, DNR will gather information on the effectiveness of its management practices through its research and monitoring program. This information will be considered

for possible future management changes through the adaptive management process. Together, research and monitoring and adaptive management should lead to more effective management in the future.

Uncertainties

Use of a Forest Estate Model for an Environmental Analysis: Advantages and Caveats

As described in the introduction to Chapter 3, this environmental analysis is based primarily on the outputs of the forest estate model (plus consideration of mitigation through current management practices). To deepen its understanding of potential environmental impacts in particular topic areas, DNR also built computer models for northern spotted owl territories and habitat, windthrow, and each riparian indicator. Each model is built using data from the forest estate model. (For more information on riparian and windthrow models, refer to Appendix G, and for more information on northern spotted owl territory and habitat models, refer to Appendix I.)

The forest estate model is a sophisticated, computer-based mathematical representation of the forest. The model is based on the best available science about how forest stands grow and change in response to a series of management activities (including harvest) and natural forest growth processes.

The forest estate model enables DNR to perform an objective, quantitative, repeatable analysis of the potential environmental impacts of the alternatives. However, using a forest estate model for an environmental analysis comes with certain caveats. No matter how effective, complex, and well built, no model can predict, to a level of absolute certainty, the exact outcome of changes to natural systems. For example, the growth and death of trees is influenced by numerous interrelated ecological factors at the stand level that the model can approximate but not fully capture. Also, natural events that can affect forest conditions, such as endemic or catastrophic windthrow or localized outbreaks of disease or insects, cannot be fully predicted or quantified.

In addition, as described in Chapter 2, DNR is aware that harvests may not be implemented on the ground exactly as they were modeled under either alternative because of unmapped streams, potentially unstable slopes not identified in the model, or other reasons. Nor does the forest estate model select for harvest any areas that are currently deferred, although as explained in Chapter 2, areas in the OESF that are currently deferred **may be released for harvest** in the future due to a change in policy, new scientific information, a change in forest conditions, or other factors.

Despite these caveats, DNR believes that the forest estate model is a highly effective and appropriate tool for this environmental analysis.

- Since this is a non-project EIS, DNR did not use the model to analyze site-specific impacts of individual timber sales; those impacts are analyzed in a separate SEPA

process at the time of the sale. Instead, DNR used the forest estate model to analyze potential impacts across a much larger area (such as a landscape) and a longer period (a 100-year analysis period).

- Models do not supply definitive answers; they supply the information necessary for making decisions. The forest estate model is built with the best science now available to DNR. Although the model will be improved in the future, DNR feels that the level of detail and accuracy the model provides today is more than sufficient to a) identify potential probable significant adverse impacts at the spatial scales at which these impacts are analyzed, and b) make informed management decisions about the alternatives based on those potential impacts.

Scientific and Data Uncertainties Identified in the Analysis

Uncertainties (incomplete knowledge) exist in analysis work but DNR believes that the information provided in this analysis is sufficient to evaluate the potential environmental impacts of the alternatives. Based on DNR's professional judgment, all analysis has been performed using the best available scientific information and techniques.

In the following section, DNR presents a list of scientific and data uncertainties identified during the development of the forest estate model and the RDEIS. Some of these uncertainties may be addressed through DNR's proposed research and monitoring program and adaptive management process. (For more information, refer to Chapter 4 of the draft OESF forest land plan in Appendix A.) DNR will use predefined criteria to prioritize and select uncertainties for research and monitoring.

Forest Conditions

- DNR's modeling and management of forests on state trust lands is based on current scientific knowledge about the growth and mortality of trees and forests. Although this knowledge is extensive, areas of uncertainty remain.

  For example, the openings in the forest created by timber harvests may be complex or irregular in shape because of the retention of trees for wildlife habitat, the protection of unstable slopes, the maintenance of riparian function, and other reasons. As trees regenerate in the opening after the harvest, their growth will be influenced by competition with each other and with the retained trees around and within the opening. These effects on growth are not fully understood at this time, and research is needed to better understand these effects and develop better models for predicting how forests grow. When DNR prioritizes uncertainties to be addressed through research and monitoring, this uncertainty will be considered. DNR also anticipates that other researchers (external to DNR) may examine this uncertainty.

- Large-scale natural disturbances, such as those resulting from catastrophic windstorms, floods, and wildfires, are inherently unpredictable due to their stochastic (random) and chaotic nature. DNR is unable to predict or model the local likelihood of these disturbances; therefore, such disturbances were not analyzed in this RDEIS.

In addition, DNR is unable to model future, site-specific, small-scale natural disturbance events as it is impossible to predict the location or severity of such events. Instead, these smaller natural disturbances are accounted for within the forest estate model in a generalized fashion in the growth and mortality estimates for trees within forest stands over time.

Northern Spotted Owl Habitat

- There is uncertainty in DNR's estimates of the amount of current Old Forest Habitat in the OESF. DNR's definition of Old Forest Habitat,[6] when applied to DNR's forest inventory,[7] often fails to identify areas known to be capable of supporting northern spotted owls (S. Horton pers. comm.). DNR uses a combination of forest inventory data and aerial photos to identify and map additional Old Forest Habitat currently in the OESF.

  In addition, using the forest estate model, DNR projects the probable future condition of the forested landscape based on a series of management activities and natural growth processes. The model compares the projected attributes of forest stands to the attributes of DNR's Old Forest Habitat definition to identify future Old Forest Habitat. The accuracy of this technique is not known at this time since most current Old Forest Habitat was identified and mapped using the combination of forest inventory data and aerial photos described in the preceding paragraph.

- This RDEIS examined the potential impacts of the alternatives on northern spotted owl habitat using the following criterion: the amount of habitat capable of providing support for the recovery of the Olympic Peninsula sub-population of northern spotted owls. The OESF's contribution to federal recovery objectives for the northern spotted owl is to provide habitat that makes a significant contribution to demographic support, maintenance of species distribution, and facilitation of dispersal.[8]

  The underlying hypothesis is that owls can be conserved by restoring habitat capability (DNR 1997). However, competition between barred owls and spotted owls is an uncertainty that may affect the success of these efforts. DNR will follow the new science on northern spotted owl/barred owl competition and the potential for forest management to influence this competition as this science evolves.

  Similarly, the long-term effects of thinning and road management on northern flying squirrel populations, a major prey species of the northern spotted owl, are uncertain. DNR's anticipates that this uncertainty will be prioritized in the proposed research and monitoring program and adaptive management process.

Riparian Conditions and Water Quality

- In-stream data such as the amount and distribution of large woody debris, presence and amount of leaf and needle litter in the stream, stream temperature, and sedimentation (settling and accumulation of sediment on the stream bed) is not available in a comprehensive or readily usable form for all streams in the OESF. Therefore, when necessary, DNR used surrogates to assess current and future conditions. Although the use of surrogates has inherent uncertainties, it is an accepted and widely-used

scientific practice (Murtaugh 1996, Messer and others 1991, Noss 1990, National Research Council 1986). Surrogates for in-stream conditions are used to analyze potential environmental impacts on riparian areas, fish habitat, and water quality.

DNR will collect in-stream data from a representative set of streams in the OESF through its Riparian Status and Trends Monitoring Project. (For a description of this project, refer to Appendix A-6 of the draft OESF forest land plan[Appendix A].)

- Because in-stream data is not available for all streams in the OESF, uncertainty exists around the amount of impaired waters (turbidity, stream temperature, or dissolved oxygen) on state trust lands in the OESF. As mentioned in the preceding paragraph, monitoring of in-stream conditions is currently being addressed through DNR's riparian status and trends monitoring project. Empirical data on stream temperature will be collected as part of this project. Sampling for dissolved oxygen and turbidity depends on additional funding and collaboration with external research partners.

- In some instances, DNR's current GIS stream layer is incomplete or inaccurate. Current mapping data may not show all streams, and mapped streams may be mistyped.

When a timber sale is implemented, streams within the sale boundary will be field-verified and buffers will be applied as described in Chapter 2 (p. 2-16) regardless of whether or not the stream was mapped or mistyped in DNR's GIS stream layer. DNR anticipates that stream typing and location data will be collected in association with harvest activities. Because data collected in the field will be incorporated into DNR's GIS stream layer, and because stream modeling techniques will continue to improve, DNR anticipates that the extent and accuracy of its stream data will improve over time.

- Leaf and needle litter recruitment is an indicator for functioning riparian habitat. The scientific knowledge of the role of Type 5 headwater streams in supplying nutrients to lower order streams (such as Type 3 or Type 4 streams) through leaf and needle litter recruitment is still evolving. When DNR prioritizes uncertainties to be addressed through research and monitoring, this uncertainty will be considered. However, research on leaf and needle litter will depend on additional funding and collaboration with external research partners.

- All traffic on unpaved forest roads can generate fine sediment. Roads can be a major source of fine sediment delivery to streams. DNR's estimate of traffic on forest roads, used to determine traffic impact scores for the water quality analysis, is based a review of past timber harvest volume reports and assumptions about harvest intensity relative to DNR's projected management activities. In addition, DNR did not estimate non-log truck traffic, such as administrative or recreational traffic.

Climate Change

- Climate change is an emerging science. The extent to which climate change will affect Pacific Northwest forests and the plant, fish, and wildlife species associated with them is uncertain. Knowledge about climate change will continue to evolve over time. Managing for a changing climate is a high priority for DNR. DNR will follow the new science on climate change and its effects as this science evolves. For

example, DNR is preparing for climate change in collaboration with the state departments of Ecology, Agriculture, Fish and Wildlife, Health, and Transportation. These departments are developing a state-wide integrated strategy for responding to climate change (Ecology and others 2011 unpublished draft).

- To estimate the amount of carbon sequestered in forest stands and in wood harvested from state trust lands in the OESF, DNR used generalized assumptions about forest productivity, tree species composition, and wood utilization based on the methodology of Smith and others (2006).

  As a result of these assumptions, and because natural disturbance events are not modeled as part of this analysis, DNR may have over- or under-estimated the amount of carbon stored or released. Despite these uncertainties, DNR anticipates that the amount of carbon stored will be far higher than the amount of carbon released under either alternative.

Endnotes

1. Natural resources conservation areas often include significant native ecosystems and geologic features, archaeological resources, or scenic attributes. Natural area preserves protect the highest quality native ecosystems and generally host more sensitive or rare species.
2. Section 303(d) of the Clean Water Act requires preparation of a list of waters in the state that do not meet water quality standards; the list is prepared every 2 years.
3. Ecology defines (2006) maximum stream temperatures and minimum dissolved oxygen levels for all water bodies in the state (refer to Appendix C for the standards applicable to water bodies in the OESF).
4. In Washington, owners of large parcels of forestland (large forest landowners) are those who harvest an annual average of more than 2 million board feet of timber from their own forestland.
5. Small forest landowners harvest an annual average of 2 million board feet or less of timber from their own forestland in Washington. They have harvested at this level for the past 3 years and do not plan to exceed this annual average harvest level for the next 10 years.
6. Type A, Type B, and High Quality Nesting habitat.
7. A type of input data used to build the forest estate model. The forest inventory database includes information about forest stands that includes tree height, diameter, species, and spacing, as well as attributes such as canopy layers, down wood, or snags.
8. Demographic support refers to the contribution of individual territorial spotted owls or clusters of spotted owl sites to the stability and viability of the entire population (Hanson and others 1993). Maintenance of species distribution refers to supporting the continued presence of the northern spotted owl populations in as much of its historic range as possible (Thomas and others 1990; USFWS 1992). Dispersal refers to the movement of juvenile, sub-adult, and adult animals (northern spotted owls) from one sub-population to another. For juvenile northern spotted owls, dispersal is the process of leaving the natal (birth) territory to establish a new territory (Forsman and others 2002; Miller and others 1997; Thomas and others 1990).