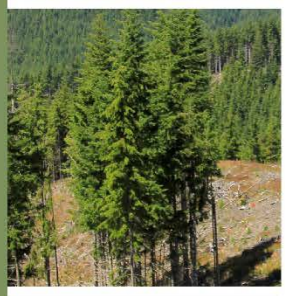

Olympic Experimental State Forest

Habitat Conservation Plan (HCP) Planning Unit

Forest Land Plan

WASHINGTON STATE DEPARTMENT OF
NATURAL RESOURCES

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Dear Supporters

The Washington state Department of Natural Resources' (DNR) forest land plan for the Olympic Experimental State Forest (OESF) guides the management of over 270,000 acres of forested state trust lands on the western Olympic Peninsula. DNR manages these temperate rain forests for both timber harvest to provide revenue to trust beneficiaries, and ecological values such as habitat for native wildlife species.

A member of the US Forest Service's National Experimental Forest and Range Network, the OESF is managed under an experimental approach called "integrated management." Instead of designating one area for timber harvest and another for wildlife habitat and other ecological values, DNR manages forested state trust lands across the OESF for both.

In this forest land plan, DNR provides foresters and managers the practical guidance they need to implement this approach on a day-to-day basis.

DNR also describes its approach to research and monitoring, in which DNR investigates the relationship between management activities and ecological conditions; its step-by-step adaptive management process, in which DNR uses new information to affirm or change its management; and its new program of operational trials, in which foresters are encouraged to innovate on logging methods and other aspects of day-to-day operations. All of these programs and opportunities will help DNR maximize the potential of the OESF as a laboratory for sustainable forest management.

DNR could not complete a plan of this magnitude without help from individuals and organizations too numerous to list. DNR extends a special thanks to everyone who has supported this forest land plan with feedback, site visits, ideas, and the generous use of their time and energy.

DNR invites you to read and learn about this unique area, from its early history to today's management goals and strategies. Thank you for your continued support of the OESF.

Kyle Blum
Deputy Supervisor for State Uplands
Washington Department of Natural Resources

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Olympic Experimental State Forest Habitat Conservation Plan (HCP) Planning Unit

Forest Land Plan

Prepared by

Washington State Department of Natural Resources

September 2016

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This forest land plan is the culmination of many years of discussion, sharing, and thoughtful collaboration with a wide range of organizations and individuals both within and outside DNR that are too numerous to list. DNR appreciates the time and attention provided by everyone who has contributed to this effort.

This plan was a collaboration between DNR's Olympic Region and the Forest Resources Division in Olympia.

- Mona Griswold, Olympic Region Manager
- Angus Brodie, Forest Resources Division Manager

A special thanks to Sue Trettevik, former Olympic Region Manager, for her leadership, knowledge, and contributions to this forest land plan.

The following contributors are listed in alphabetical order.

DNR Olympic Region
Kevin Alexander, Planning Forester
Andrew Gorbett, Unit Forester
Scott Horton, Wildlife Biologist
Brett McGinley, Unit Forester
Mike Potter, Unit Forester
Drew Rosanbalm, Assistant Olympic Region Manager
Jesse Steele, former Unit Forester
Bill Wells, Coast District Manager

Forest Resources Division
David Bergvall, Assistant Forest Resources Division Manager
Cathy Chauvin, Communication Consultant
Weikko Jaross, Senior Forest Analyst
Scott McLeod, Silvicultural Scientist
Heather McPherson, Wildlife Biologist
Teodora Minkova, OESF Research and Monitoring Manager
Rebecca Niggemann, GIS Analyst
Jeff Ricklefs, GIS Analyst
Chris Snyder, GIS Analyst
Heidi Tate, Forest Land Planning Program Manager

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1

Background

In this chapter, DNR describes the planning area and provides a brief history of the OESF.

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Background

Located on the western Olympic Peninsula, the Olympic Experimental State Forest (OESF) is a place of high rainfall, steep and rugged terrain, numerous streams and rivers, and temperate rain forests with extraordinary tree growth rates that provides both quality timber for harvest and habitat for native species such as northern spotted owls and marbled murrelets.

In the OESF, the Washington State Department of Natural Resources (DNR), a state agency, meets objectives for timber harvest (to produce revenue for trust beneficiaries), and wildlife habitat, biodiversity, and other ecological values through an experimental, integrated management approach. Unlike the more common approach of dividing a land base into one area for harvest and another for habitat, DNR manages the entire land base for both.

A center of experimentation for DNR, the OESF is unique from other experimental forests in the United States because it is not purely a research forest. It is a *working* forest with annual and decadal timber volume targets. Nowhere in the United States is a working forest of this size being managed under an experimental approach with the stated purpose of learning.

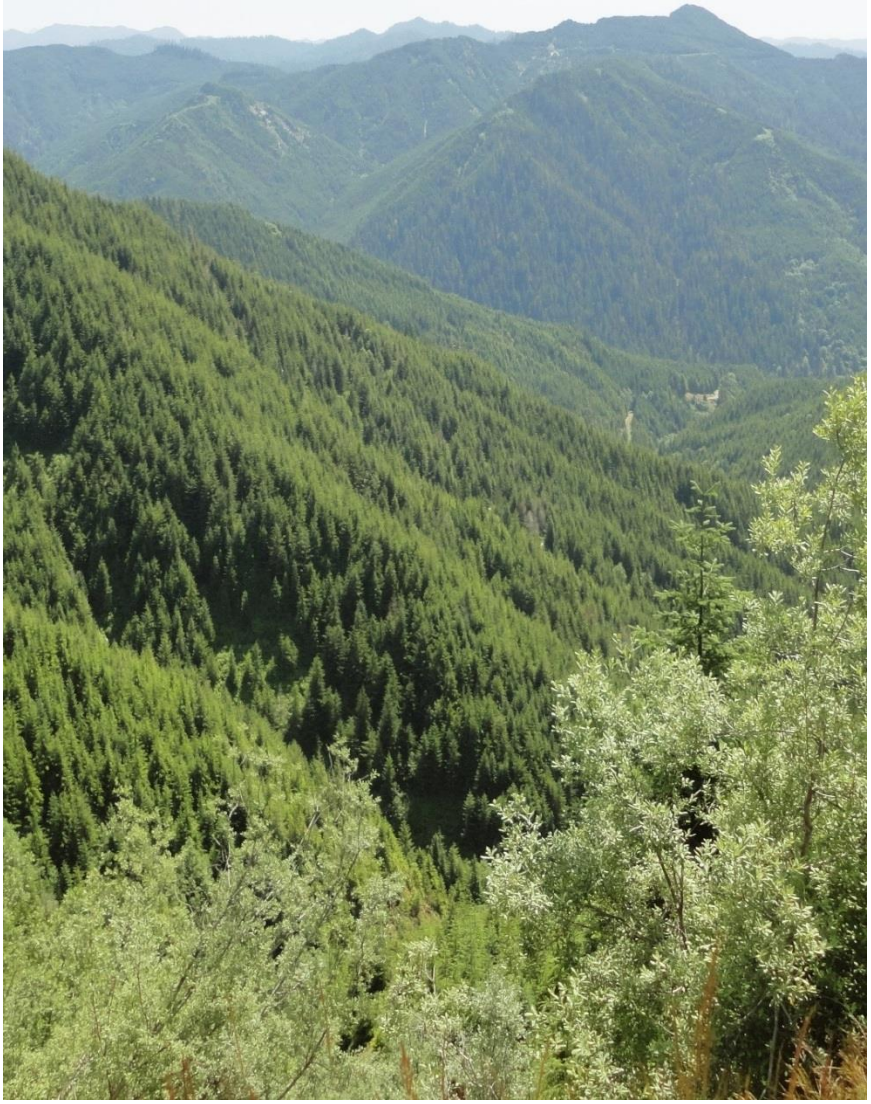
In the OESF, DNR intentionally learns by doing, experimenting with new silvicultural techniques and conducting research and monitoring in conjunction with ongoing timber harvest and other management activities to understand critical links between those activities and resultant ecological conditions. Course corrections are made along the way through an adaptive management process. DNR shares what it learns both within DNR and with other land managers facing similar challenges of meeting multiple objectives in a working forest.

In the following forest land plan, DNR describes the history of the OESF, the integrated management approach as implemented today, DNR's goals, objectives, and strategies for managing the OESF, and DNR'a approach to the learning that is central to the purpose of this unique area.

DNR's Mission and Vision for the OESF

Mission: **To intentionally learn how to integrate revenue production and ecological values in a working forest.**

Vision: **A productive, healthy, biologically diverse working forest that provides a perpetual supply of revenue to trust beneficiaries as well as ecological values.**



About This Plan

This forest land plan provides DNR managers and foresters the practical guidance and direction they need to implement the integrated management approach as well as DNR policies including the *Policy for Sustainable Forests* and the *State Trust Lands Habitat Conservation Plan* (HCP). Following is an overview of these policies and their major provisions affecting the OESF:

- The *Policy for Sustainable Forests* guides the management of 2.1 million acres of forested state trust lands (state trust lands are described later in this chapter). This document includes policies on **producing revenue** for trust beneficiaries and maintaining **ecological values** including forest ecosystem health and productivity, wildlife habitat, riparian conservation, special ecological features, and watershed systems.

- The HCP is a long-term management plan authorized under the Endangered Species Act (16 U.S.C. 1531 et seq.) [1] that describes, in a suite of habitat conservation strategies, how DNR restores and enhances habitat for threatened and endangered species in conjunction with timber harvest and other forest management activities. The HCP includes four major habitat conservation strategies in the OESF: the **riparian conservation strategy**, which includes requirements for salmonid habitat and habitat for other aquatic and riparian-obligate species; the **northern spotted owl** and **marbled murrelet conservation strategies**, which include requirements for restoring and maintaining habitat for these species; and the **multispecies conservation strategy**, which covers unlisted species and species that face at least some risk of local extinction. Per the HCP and the Implementation Agreement (Appendix B to the HCP) DNR also implements **adaptive management** and **research and monitoring.**

Although DNR does not change policies through forest land planning, information gathered through plan implementation may inform future

policy decisions. Should DNR policies change in the future, DNR will revise this plan if and as necessary.

Plan Organization

This plan is organized into five chapters.

1. Background

In this chapter, DNR describes the planning area and provides a brief history of the OESF, including the evolution of the integrated management approach over time.

2. Management Approach

This chapter is a comprehensive overview of the integrated management approach as is implemented today.

3. Goals, Objectives, and Management Strategies

This chapter spells out the *what* and the *how* of this forest land plan for foresters and others responsible for day-to-day management. It includes DNR's goals, measurable objectives, and management strategies for generating revenue and implementing the HCP conservation strategies and research, monitoring, and adaptive management.

4. Research, Monitoring, and Adaptive Management

This chapter provides a detailed description of the adaptive management process and research and monitoring program. DNR describes both in a separate chapter to highlight their importance to the OESF.

5. Glossary of Terms

DNR provides brief definitions of the key terms used in this plan.

6. References

This chapter provides a list of references used in this plan.

This plan is intended as a living document that will be updated as needed during plan implementation. DNR will consider each change to ensure it falls within the range of the potential environmental impacts analyzed in

the final environmental impact statement prepared for this plan. If not, additional environmental analysis may be required.

In addition to this plan, DNR also maintains a "living library" of up-to-date information that foresters and managers need on a daily basis. Located on DNR's intranet, the OESF Living Library includes documents, such as this forest land plan; links to DNR's research database; a discussion board; mapping; and business intelligence such as current harvest volumes, progress toward management objectives, and other data that is continually updated to inform timber sale planning.

Old Growth Forest in the OESF

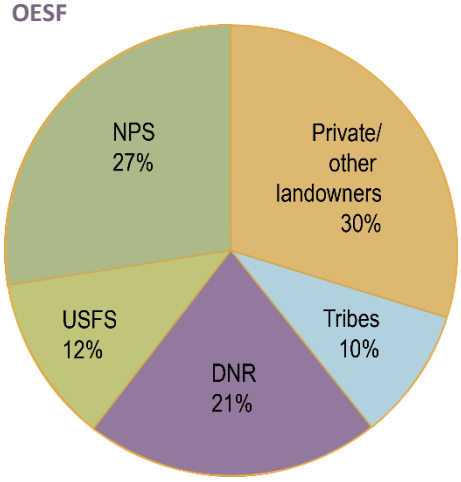
Planning Area

The OESF is bordered approximately by the Pacific Ocean to the west, the Strait of Juan de Fuca to the north, and the Olympic Mountains to the east and south (refer to Map 1-1).

Map 1-1. OESF and Vicinity

The OESF is one of nine planning units designated under the HCP. Because planning unit boundaries are established largely along watershed lines, the OESF includes lands managed by DNR as well as other owners, such as the National Park Service (NPS), United States Forest Service (USFS), tribes, private landowners (including timber companies), and others (Chart 1-1). DNR manages about 21 percent (approximately 272,000 acres) of the OESF. **This forest land plan applies *only* to DNR-managed lands within the OESF boundaries**.

Chart 1-1. Land Ownership in the OESF



The Natural Environment

Mostly forested, DNR-managed lands in the OESF ranges in elevation from approximately 18 to 3,790 feet and spans three major vegetation zones: western hemlock (approximately 43 percent of DNR-managed lands), Sitka spruce (33 percent) and Pacific silver fir (24 percent).

Forested Valley in the OESF

Seasonal rainfall of 80 to 180 inches per year is a notable climatic feature of the OESF. The climate is maritime (strongly influenced by the Pacific Ocean) with relatively dry summers and significant precipitation (usually rain) during the winter. High rainfall often translates to extraordinary tree growth rates.

Steep terrain and heavy annual precipitation promote an abundance of small streams. Stream density (miles of stream per square mile of land area) is particularly high in U-shaped glacial valleys such as the Hoh, Bogachiel, and Sol Duc drainages.

Wetland in the OESF

Wetlands are found in the coastal lowlands and valley bottoms of the major river systems in the OESF, including the lower Queets, Clearwater, Kalaloch, Hoh, Mosquito, Goodman, Bogachiel, Quillayute, Dickey, and Ozette rivers and their tributaries. Bogs, a special type of wetland that accumulates peat, are generally rare across Washington but are found in the OESF because of its geological history.

Types of DNR-managed Lands in the OESF

Most of the lands DNR manages in the OESF are state trust lands. State trust lands are lands held as fiduciary trusts for specific trust beneficiaries, such as schools and universities (refer to Text Box 1-1 on p. 1-9). On these lands, DNR produces revenue for its beneficiaries primarily through the sale and harvest of timber. The term "state trust lands" includes both State Lands and State Forest Lands:

- **State Lands** (RCW 79.02.010(14)): Shortly before Washington became a state in 1889, Congress passed the Enabling Act (25 U.S. Statutes at Large, c 180 p 676) to grant the territory more than 3 million acres of land as a source of financial support, primarily for its public schools and colleges. Unlike states that sold many of their federally granted lands early in the 1900s, Washington retained ownership of most of these lands and continues to manage them to provide revenue and other benefits to the people of Washington (DNR 2006). These lands are called State Lands.

- **State Forest Lands** (RCW 79.02.010(13)): Other lands were acquired by Washington from the counties. By the 1930s, counties had acquired 618,000 acres of foreclosed, tax-delinquent, cut-over, and abandoned forestlands. These scattered lands were difficult for the counties to manage, so the Washington State Legislature directed the counties to deed them to the state. The legislature directed that these lands be held and managed in trust, the same as State lands. These lands are called State Forest Lands.

Text Box 1-1. What is a Trust?

A trust is a relationship in which a person (or entity), the trustee, holds title to property that must be kept or used for the benefit of another, the beneficiary. According to the *Policy for Sustainable Forests*, a trust includes a grantor (the entity establishing the trust, such as the federal government), a trustee (the entity holding the title), one or more trust beneficiaries (entities receiving the benefits from the assets), and trust assets (the property kept or used for the benefit of the beneficiaries) (DNR 2006 p. 14). Washington state is the trustee of state trust lands and DNR is the trust land manager.

The 1984 landmark decision *County of Skamania v. State of Washington* addressed two key trustee duties. Washington's Supreme Court stated that 1) a trustee must act with undivided loyalty to the trust beneficiaries, to the exclusion of all other interests; and 2) a state's duty as trustee is to manage trust assets prudently (DNR 2006). The Washington State Legislature, as trustee, requires the Board of Natural Resources and DNR, as the trust land manager, to establish policies to ensure that, based on sound principles, trust assets are managed for sustainable benefit to the trusts in perpetuity. Refer to the *Policy for Sustainable Forests*, pages 9 through 16, for a complete description of DNR's trust management duties.

The OESF also includes approximately 3,500 acres of natural resource conservation areas and natural area preserves. These areas are permanently deferred from timber harvest and contribute towards DNR's conservation objectives. Following is a list of these areas in the OESF.

- **South Nolan Natural Resource Conservation Area:** Old-growth coastal forest, forested sphagnum bog,[2] and low elevation sphagnum bog.
- **Clearwater Corridor Natural Resource Conservation Area:** Mature coastal forest, aquatic-riparian habitat.
- **Shipwreck Point Natural Resource Conservation Area:** Straight of Juan de Fuca beach, stream and riparian habitat, and coastal forest.
- **Clearwater Bogs Natural Area Preserve:** Forested sphagnum bog, low elevation sphagnum bog.

► A Changing Land Base

DNR expects the land base to change over time. For example, DNR may consolidate state trust lands in certain areas to allow for more cost-effective management. To consolidate state trust lands, DNR often works

with owners of adjacent lands to exchange their properties for parcels of state trust lands of equal value elsewhere. DNR's long-term goal for land transactions is to maintain approximately the same value of the land to keep each trust "whole."

Administrative Designations

►Landscapes

To assist in the planning and management of state trust lands in the OESF, DNR divided the OESF into 11 administrative areas called landscapes. Based on current data, acres of DNR-managed lands within each landscape range from approximately 8,900 to over 50,000 acres (refer to Table 1-1). Landscapes are used to implement the northern spotted owl conservation strategy, as will be explained in Chapter 3.

Table 1-1. Acres of DNR-managed Lands in the OESF, by Landscape (Current as of 2016)

Landscapes	Acres of State Trust Lands
Clallam	18,043
Clearwater	57,467
Coppermine	20,646
Dickodochtedar	28,387
Goodman	25,197
Kalaloch	20,203
Queets	23,586
Reade Hill	10,453
Sekiu	8,990
Sol Duc	20,159
Willy Huel	39,375
TOTAL	272,506

►Type 3 Watersheds

To manage the OESF, DNR also uses a much smaller unit called a Type 3 watershed. There are over 600 Type 3 watersheds in the OESF. Type 3 watersheds are used to implement the riparian conservation strategy, as will be explained in Chapter 3.

A Brief History of the OESF

Past Harvest

Timber harvest operations on the Olympic Peninsula began in the late 1800s when the harvested timber was hauled out by trains. The extent of harvest was limited by difficult terrain that trains could not navigate.

Demand for Pacific Northwest timber in the late 1800s was spurred largely by the Klondike gold rush of 1897 and the building boom in Seattle (Rutkow 2012). By the early 1900s, demand for Pacific Northwest lumber was being influenced by World War I: strong Sitka spruce was needed to construct airplane wings (Evans and Comp 1983). The best stands of Sitka spruce, in terms of both quality and accessibility, resided exclusively in the Pacific Northwest (Rutkow 2012).

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). Pacific Northwest production soon accounted for 30 percent of the national total (Rutkow 2012). Harvest of older forests accelerated between 1949 and 1970, with most harvest taking place in old-growth forests (United States Fish and Wildlife Service [USFWS] 1997).

Example of a Forest Plantation

Until the late 1980s, DNR had a policy to harvest the oldest timber first (DNR 1979) to provide greater long-term financial benefits to the trusts. Between 1970 and 1990, over half of the state trust lands that would later be included in the OESF were clearcut and replanted. Per Washington's forest practices rules, clearcutting is a harvest method in which the entire stand of trees is removed in one timber harvest operation (WAC 222-16-010). Clearcutting was common across ownerships at that time and left a legacy of forest plantations that were structurally simple and provide little support for ecological values (refer to photo, above).

1989 Commission on Old Growth Alternatives for Washington's Forest Trust Lands

Under DNR's policy to harvest the older timber first, harvest projections in 1988 indicated that most of the remaining natural, mature forests (approximately 60,000 acres) on state trust lands on the western Olympic Peninsula would be harvested within 15 years (Commission on Old Growth Alternatives for Washington's Forest Trust Lands [Commission] 1989). Harvest levels would then drop steeply for several decades until sufficient second growth was available to support higher harvest levels around 2030 (Commission 1989).

DNR recognized that this policy would have repercussions for trust beneficiaries, local communities, and the ecological diversity of the forest environment. To address these concerns, in 1989 DNR created the Commission to advise then-Commissioner of Public Lands Brian Boyle and DNR on the future management of old-growth forests on state trust lands on the western Olympic Peninsula. The Commission was comprised of 32 citizens broadly representative of the timber industry, conservation and wildlife groups, school and other trust beneficiaries, tribes, local Olympic Peninsula community leaders, members of the legislature, and financial, legal, and forestry experts. The Commission charter required balanced solutions to address the following issues:

- The future generation of revenue to trust beneficiaries, and the future flow of timber from state trust lands to local industry and communities and to ultimate markets;
- The future ecological diversity of state trust lands on the western Olympic Peninsula;
- The availability of wildlife habitat on state trust lands, especially habitat for rare and endangered species including the northern spotted owl, which was being considered at that time for listing under the Endangered Species Act;and
- The possibility of preserving in perpetuity on state trust lands some examples of original forest cover for aesthetic, recreational, and spiritual values.

To address these issues, the Commission made a consensus recommendation to establish the OESF on western Olympic Peninsula state trust lands. In the OESF, DNR would stabilize the supply of revenue and provide for ecological values by investigating a new management concept:

> "Forest scientists and managers are increasingly discussing the ability to sustain key elements of ecological diversity within managed commercial forests as an alternative to past approaches. The Commission sees a clear need for further research in this area and a great opportunity to conduct it on state-owned lands. The intent is to experiment with harvest and regeneration methods to enhance habitat characteristics and commodities production" (Commission 1989).

The basic concept was to continue harvesting old-growth forests at a slower rate than before, while simultaneously studying such forests to understand their functions and how to replicate them within managed forest stands. To this end, the Commission recommended that for 15 years, DNR defer harvest of 15,000 acres of mature, natural stands identified by wildlife biologists as crucial to northern spotted owls. During this time, DNR would conduct research "aimed particularly at showing how future harvest in these deferred areas could occur simultaneously with retention of key ecological features" (Commission 1989). At the end of 15 years, DNR would make a decision on whether to harvest these 15,000 acres. In addition, the Commission recommended that 3,000 acres of state trust lands with special ecological, aesthetic, or interpretive values be deferred permanently from timber harvests. These areas were designated as natural area preserves and natural resource conservation areas.

The Commission also recommended designating the OESF as an independent sustainable harvest unit. As an independent unit, the OESF would be assigned its own decadal sustainable harvest level. Assigning the OESF its own level would stabilize the supply of wood to the local economy and slow (but not stop) the harvest of old-growth forest on state trust lands. (The sustainable harvest level will be discussed in Chapter 3.)

These recommendations united interests from a broad group of stakeholders and demonstrated the power of cooperation. All recommendations were accepted by the Board of Natural Resources.

Preliminary Planning: the 1991 Draft OESF Forest Management Plan

DNR carried the recommendations of the Commission on Old Growth Alternatives forward into the draft 1991 OESF Management Plan (1991 Plan). DNR developed the 1991 Plan in cooperation with an old-growth advisory group comprised of a subset of participants from the Commission, a scientific panel, and a local technical group. Although this plan provided a conceptual framework for management of state trust

lands in the OESF, it was neither finalized nor adopted, as will be explained later in this section.

DNR believed, then as now, that good stewardship in the OESF means more than managing state trust lands for long-term income; it means ensuring successful renewal of the forest and maintenance of the forest ecosystem (DNR 1991). To this end, DNR identified four general categories of ecological values as a starting point for research and management. These categories were long-term site productivity, watershed/aquatic habitat, biological diversity, and ecosystem resilience (refer to Text Box 1-2).

Text Box 1-2. What are Ecological Values?

Ecological values are defined by DNR as the elements (for example trees, wildlife, soil, water) and natural relationships between these elements that are biologically and functionally important to the continued health of the forest ecosystem (DNR 1991).

- **Long-term site productivity:** The ability of an area to support plants and wildlife.
- **Riparian areas and aquatic habitat:** Aquatic habitat includes streams and other water bodies. Riparian areas are where aquatic and terrestrial ecosystems interact (such as wetlands and riparian forests).
- **Biodiversity:** the full range of life in all its forms (Washington Biodiversity Council).
- **Ecosystem resilience:** Ability of an ecosystem to recover from disturbance.

Per the 1991 Plan, management of state trust lands in the OESF would focus on meeting goals and objectives for revenue production and ecological values across the *same* lands, rather than designating some areas strictly for revenue and others for ecological values. This approach, later called "integrated management," would test the hypothesis that commercial harvest is possible without jeopardizing identified ecological values (DNR 1991).

DNR's primary approach to achieving ecological values and revenue production was to manage for forest structure at both a stand and landscape level. This approach was based on the following premise: that if DNR left (when harvesting mature forests) or created (when managing second growth) a diversity of forest structures across state trust lands, DNR could meet most of the habitat needs of native plant and wildlife species (DNR 1991). Examples of structure include snags, down wood, multiple canopy layers, forest openings, and stands in different development stages. DNR further refined this approach by defining preliminary target percentages for specific forest structure types such as old growth, open canopy, closed canopy, understory, layered canopy, or hardwoods/brush across state trust lands (DNR 1991). These targets would be further refined and tested through research and monitoring.

DNR did not assume that the needs of all wildlife species would be met by managed stands. DNR assumed that old-growth forests would remain on the landscape in natural area preserves, natural resource conservation areas, and adjacent ecological reserves such as Olympic National Park and Olympic National Forest (DNR 1991).

The 1991 Plan also recommended that the OESF be divided into 11 landscapes, primarily along hydrologic boundaries. DNR believed that if initial planning was based on broad geographic areas and was tied to structural features important to the health of the ecosystem, decisions could be made that optimized revenue production and ecological values (DNR 1991).

DNR's Olympic Region developed a landscape plan for the Clallam landscape in 1995. DNR's Olympic Region staff also developed preliminary landscape plans for the Goodman, Reade Hill, Willy-Huel, and Kalaloch landscapes (collectively referred to as the Mid-coast landscape) in 2001.

The 1991 Plan provided broad guidance for selecting research activities and implementing adaptive management. The plan also outlined a harvest techniques program. The goal of the program was to develop and apply harvest techniques to better integrate revenue production and ecological values (DNR 1991). Techniques included retention during harvest of key structural features such as large trees, large snags, down woody debris, and remnants of intact forest.

1992 Forest Resource Plan

The OESF's status as an experimental forest and a separate sustainable harvest unit was confirmed in the 1992 *Forest Resource Plan*. This plan, which guided management of all forested state trust lands in Washington, described the purpose of the OESF as "to gain and apply knowledge about old-growth forests and modern commercial forest management," establishing it as an experimental forest. This plan also described the OESF as a forest that would be managed separately from other lands in western Washington, establishing it as an independent sustainable harvest unit (DNR 1992).

Threatened Species and the HCP

In 1990, USFWS issued a final rule listing the northern spotted owl (*Strix occidentalis caurina*) as a threatened species under the Endangered Species Act. Listing of the marbled murrelet (*Brachyramphus marmoratus*) followed two years later.

In 1992, the United States Congress passed the Olympic Experimental Forest Act (Title II of P.L. 102-436(106 Stat. 2217)). The Act gave DNR permission to prepare a plan that would "provide for the conservation of the northern spotted owl on the forest and reflect scientifically sound ecosystem management to aid conservation of fisheries, other sensitive species, and the ecology of the forest in general" through an experimental management program. Once this plan was approved by USFWS, actions conducted under this plan would not be considered prohibited take of the northern spotted owl under the Endangered Species Act (refer to Text Box 1-3).

Text Box 1-3. What is Prohibited Take?

The Endangered Species Act makes it unlawful to "take" a listed animal without a permit. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." Through regulations, the term "harm" is defined as "an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (USFWS 2013).

At this point, DNR had a number of options. It could finalize the 1991 Plan to meet the requirements of the Olympic Experimental Forest Act. It could designate critical habitat. Or it could prepare a multi-species HCP. Under the direction of Jennifer Belcher, the newly elected Commissioner of Public Lands and former member of the Commission, DNR chose the latter.

Authorized under the Endangered Species Act, an HCP is a plan that takes a broad, landscape approach to minimizing and mitigating impacts to threatened and endangered species while conducting lawful activities such as forest practices (DNR 1997). The HCP describes the steps DNR takes to offset any harm of individual members of a listed species by promoting the conservation of the species' habitat.

An HCP is part of an application for an incidental take permit, which allows incidental take of a threatened or endangered species. Incidental take is the taking of a federally listed wildlife species, if such take is incidental to, and not the purpose of carrying out otherwise lawful activities (DNR 1997).

DNR originally considered preparing the HCP specifically for the OESF, but later decided to prepare one HCP for all state trust lands within the range of the northern spotted owl and to include the OESF as a separate planning unit. The HCP was completed and approved in 1997 and an incidental take permit was issued.

►A Shift in Management

The HCP represented a shift in how DNR managed the OESF. The 1991 Plan was not species specific; DNR would manage the entire OESF to support a diversity of native species, rather than mange some areas specifically for one species. DNR would create "a broad landscape spectrum of wildlife habitat from grass, forb, and shrub to mature timber" (DNR 1991).

However, to meet the requirements of the Endangered Species Act, DNR needed provisions for specific types of wildlife habitat. DNR developed conservation strategies for northern spotted owl, riparian (for salmon and other riparian-obligate species), and marbled murrelet habitat. A fourth strategy covered habitat for multiple species.

DNR designed each of these strategies in a way that ensures the original intention of the OESF—to learn how to integrate revenue production and ecological values across the land base—remained intact. DNR provides an overview of these strategies and how they relate to integrated management in Chapter 2.

Biodiversity Pathways and the Washington Forest Landscape Management Project

In 1992, a group of leading scientists from DNR, USFS Pacific Northwest Research Station, Washington State Department of Fish and Wildlife (WDFW), University of Washington, and Oregon State University formed a working group for the Washington Forest Landscape Management Project (Project). The Project's original purpose was to explore ways in which landscape management could be implemented across ownerships to meet the needs of wildlife associated with late-seral stage forests while minimizing impacts on revenue production in Washington's Forests (Carey and others 1996). The original study area was the 770,000-acre Quileuite/Hoh water watershed. However, due to the difficulties of attaining sufficient and comparable data across ownerships and other challenges, the working group decided to focus the project on a much smaller area (approximately 17,000 acres) managed primarily by DNR: the Clallam Landscape in the OESF. (This project was completely separate from development of the Clallam Landscape plan described earlier in this history.)

The Project developed six forest management scenarios, one of which was maximizing biodiversity through an approach they termed "biodiversity pathways." Biodiversity pathways included techniques

such as conservation of biological legacies at harvest (snags, down wood, large trees, and other features); pre-commercial thinning to bypass the competitive exclusion stand development stage and promote woody plant diversity; thinning at variable densities to promote heterogeneity; widely spaced planting of Douglas-fir and natural regeneration of western hemlock, western red cedar, and deciduous trees; and longer rotations (70-130 years). Other scenarios included no management, wide riparian buffers and maximizing net present value on remaining areas, forest practices-defined riparian buffers and maximizing net present value in remaining areas, and two variations on biodiversity pathways (thinning in different decades with shorter or longer rotations plus maximizing net present value). All scenarios had the goal of achieving 30 percent of the landscape in late-seral forest.

Through modeling, the Project simulated changes that would occur in the landscape over a 300-year period under each management scenario. Results showed that maximizing biodiversity through biodiversity pathways achieved 30 percent late-seral forest more quickly than other management scenarios and produced significant economic benefits (Carey and others 1996). By contrast, those scenarios that involved maximizing net present value resulted in a higher economic value but the highest risk to species (Carey and others 1996). Results were published in *Washington Forest Landscape Management Project – a Pragmatic, Ecological Approach to Small-Landscape Management.*

In 2004, DNR incorporated biodiversity pathways techniques into the preferred alternative for the 2004-2014 sustainable harvest calculation environmental impact statement. Called "Innovative Silvicultural Management," this alternative consisted of existing DNR silvicultural practices, more intensive silviculture, and the following biodiversity pathways techniques: retaining biological legacies at harvest; underplanting widely-spaced, site-appropriate coniferous species to supplement natural regeneration of tree and shrub species; minimizing site preparation (to disturb fewer forest ecosystem processes); thinning to variable densities to encourage development of an understory; and improving habitat by creating snags and felling trees to create structure (DNR 2004).

As an outcome of the 2004 sustainable harvest calculation, DNR wrote a silvicultural policy based on the preferred alternative. Called the "General Silvicultural Strategy Applied to Timber Resources Base Available for Sustainable Harvest in Western Washington," this policy stated that "the department will use intensive and innovative silviculture to guide the desired progression of stand development to simultaneously produce trust revenue and create structural complexity" (DNR 2004). The policy described biodiversity pathways as a type of innovative

silviculture that could be used to "create, develop, enhance, or maintain forest biodiversity and health" (DNR 2004).

In 2006, DNR finalized and incorporated the general silvicultural strategy into the *Policy for Sustainable Forests* (DNR 2006, p. 46). In this manner, biodiversity pathway techniques became part of DNR's policy for creating and maintaining structural diversity in all of its management areas, including the OESF. These techniques have been integrated into cohort management, the silvicultural system DNR uses to manage state trust lands throughout Washington. (Cohort management will be described in Chapter 2).

Biodiversity pathways are an important tool for integrating revenue production and ecological values. Although today these techniques are being practiced in all DNR planning units, only in the OESF are they implemented within the full framework of integrated management. The OESF is where DNR learns how effective these techniques are in achieving multiple objectives in managed stands.

Deferrals and the Policy for Sustainable Forests

Adopted in 2006, the *Policy for Sustainable Forests* deferred all old-growth forests[3] in the OESF, including the 15,000 acres deferred temporarily at the founding of the OESF and all remaining acres for a total of approximately 48,000 acres. In addition to old growth, the *Policy for Sustainable Forests* also continued the deferral of gene pool reserves, which are examples of natural forest cover needed to sustain the native gene pool. Both gene pool reserves and old-growth forests will remain deferred until and unless policies change.

Today, DNR uses deferrals to help meet its ecological objectives per the conservation strategies. For example, many old-growth stands are also Old Forest Habitat that contributes toward requirements for northern spotted owl habitat. And because deferrals are not co-located in a single contiguous block but interspersed with more actively managed areas, they help DNR realize an important concept of integrated management: a working forest with a full-range of forest conditions (DNR 1997 p. IV.81).

2016 Final Environmental Impact Statement and Forest Land Plan

In 2016, DNR prepared a final environmental impact statement for this forest land plan. In that document, DNR identified a range of possible

alternatives for the future management of the OESF. One of these alternatives was to apply management "pathways" to each landscape to help implement the northern spotted owl conservation strategy. All of DNR's alternatives were based on the integrated management approach.

After publishing the final environmental impact statement, DNR prepared this forest land plan and incorporated the pathways concept into its strategies for northern spotted owl habitat. Pathways will be discussed in Chapter 3.

The 1991 Plan and the HCP anticipated that DNR would write separate management plans for each landscape in the OESF. At that time, technology for processing and analyzing large amounts of data was limited. Today, the sophistication of current analysis tools enables DNR to write one plan that covers all 11 landscapes. These tools and DNR's planning process will be discussed in Chapter 2.

Integrated Management: Looking Back, Looking Forward

The integrated management approach has evolved over time. This is an experimental forest; such change are expected and will continue to occur in the future. In Chapter 2, DNR describes the processes it uses to implement integrated management today, with the understanding that DNR's approach may change again in the future as DNR continues its intentional learning in the OESF.

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1 The Endangered Species Act of 1973 (as amended) provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend. The Endangered Species Act authorizes federal fish and wildlife agencies to list species that are threatened with or in danger of extinction and prohibits the unauthorized taking of listed species.

2 Sphagnum is a genus of approximately 120 species of mosses, commonly known as peat moss.

3 Per the *Policy for Sustainable Forests*, structurally complex forest stands five acres or larger that originated naturally prior to 1850.Per current policy, Old-growth forests in the OESF are deferred from harvest, but DNR may conduct operations in old-growth consistent with the requirements of the HCP to meet the research objectives of the OESF (DNR 2006).

Acronyms

dbh	Diameter at breast height
DNR	Washington Department of Natural Resources
GIS	Geographic information system
HCP	*State Trust Lands Habitat Conservation Plan*
LRM	Land resource manager database
NMFS	National Marine Fisheries Service
NPS	National Park Service
OESF	Olympic Experimental State Forest
RCW	Revised code of Washington
RMAP	Road maintenance and abandonment plan
SAF	Society of American Foresters
SEPA	State Environmental Policy Act
SOMU	Spotted owl management unit
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USGS	United States Geological Survey
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WAC	Washington administrative code
WDFW	Washington Department of Fish and Wildlife
WFPB	Washington Forest Practices Board

Other

Federal Services	NOAA Fisheries and USFWS

2

Management Approach

This chapter is a comprehensive overview of the integrated management approach as implemented today.

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Management Approach

Under integrated management, DNR supports revenue production and ecological values by creating and maintaining a biologically diverse working forest, with healthy streams and wetlands, a mix of tree species, and a diversity of forest structures at the stand and landscape level.

Structural diversity at the stand level includes down wood, snags, canopy layers, and other elements. Structural diversity at the landscape level includes open areas and stands of varying densities and developmental stages from newly planted to mature, including old growth. DNR achieves structural diversity in three primary ways:

- DNR harvests timber to produce revenue for trust beneficiaries in a way that creates and maintains a diversity of forest structures within and across forest stands. For example, DNR thins forest stands to a variety of densities and uses variable retention harvest techniques in which green trees, snags, down wood, and other structural features are retained between one forest rotation and the next to enrich the structural diversity of the new stand.

- Under its HCP conservation strategies, DNR places buffers on streams, limits harvest in wetlands and their management zones and on potentially unstable slopes and landforms, restores and maintains a percentage of each landscape as northern spotted owl habitat, and protects types of marbled murrelet habitat. These practices result in retention of forest stands ranging from young to mature in a highly variable spatial arrangement across the land base.

- DNR intersperses areas deferred per current DNR policies, such as old-growth forests, with areas that are more actively managed.

These practices are aimed at producing a biologically diverse forest that provides quality timber for harvest and habitat for native species. As this

approach is implemented, DNR intentionally learns from it through research and monitoring and consider new information through the adaptive management process.

In the following chapter, these and other concepts will be explained in more detail. The discussion is organized around the following seven major components of integrated management:

- Silviculture
- HCP conservation strategies
- Planning from a landscape perspective
- Research and monitoring
- Adaptive management
- Information management
- Effective communication

A graphic is provided at the start of each section to help readers navigate this chapter.

At the end of this chapter, DNR also discusses response to natural disturbances and adaptation to climate change.

Forest in the OESF

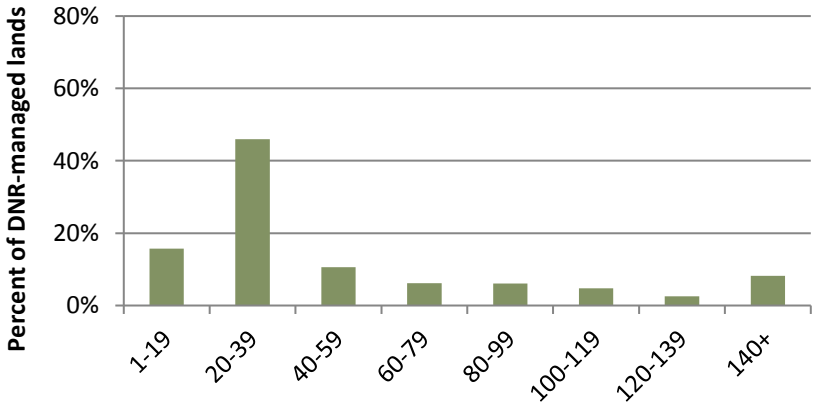
Silviculture

The OESF currently has many structurally simple stands that are a legacy of past clearcuts (carried out under DNR policies that are no longer in place) and widespread natural disturbances such as major windstorms. Chart 2-1 shows that forests across approximately half of state trust lands in the OESF are between 20 and 39 years of age. Over half of the forests on state trust lands in the OESF are in the "Competitive Exclusion" stand development stage, a single-canopy stage in which trees are closely spaced and stands typically lack the down wood, snags, and other structural characteristics of later stages.

Silviculture is the principle tool by which DNR introduces and maintains structural diversity within and across forest stands across the OESF. Following, DNR describes the silvicultural system and harvest methods it uses to accomplish this. The information in this section is meant as a starting point. This is an experimental forest, and techniques are expected to evolve over time.

Chart 2-1. State Trust Lands Forest Stand Age Class Distribution

Based on 2011 Data



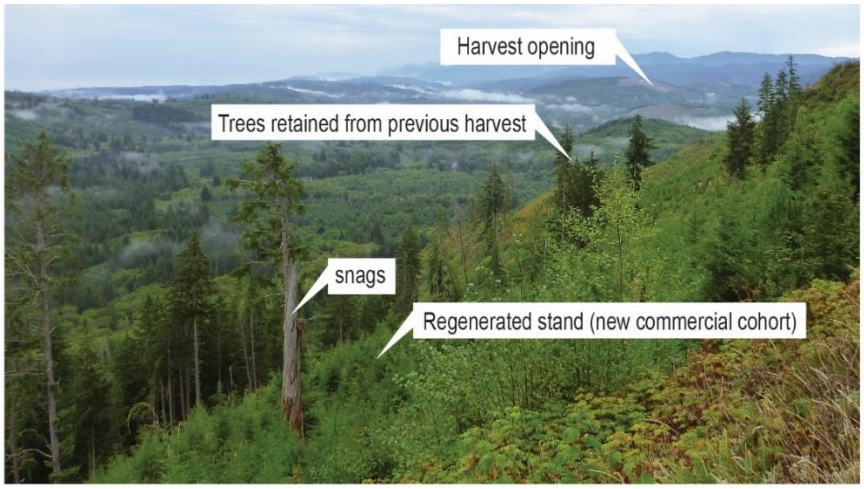
DNR's Silvicultural System: Cohort Management

In the OESF, DNR uses a silvicultural system that focuses on the management of **cohorts**. Cohorts are the portions or attributes of a forest stand that can be defined and managed for, such as large legacy trees, snags, down wood, or a group of trees of similar age and species.

DNR's silvicultural system is called **cohort management,** which is the simultaneous management of multiple cohorts within an area to meet objectives (refer to Figure 2-1). For example, DNR may remove the commercial cohort to generate revenue, while retaining snags, down wood, structurally unique trees, and other "biological legacy" cohorts to support ecological values. By managing cohorts, DNR can intentionally diversify a stand's structure, and by applying cohort management across the landscape, DNR can generate revenue and achieve a variety of stand densities and structures to support ecological values across the OESF.

Figure 2-1. Cohort Management

By leaving some cohorts and removing others, DNR creates and maintains combinations of forest structures within and across forest stands.



The primary harvest techniques used under cohort management incorporate key principles of biodiversity pathways such as retention of biological legacies at harvest (variable retention harvest) and non-uniform thinning (variable density thinning). A third principle of biodiversity pathways, natural regeneration, occurs in smaller forest openings with complex edges, as will be discussed in the following section.

Both variable density thinning and variable retention harvest represent a single entry into the stand. Although some ambiguity exists between them, for DNR the primary difference is whether regeneration is planned

and managed for following a harvest (as with variable retention harvest) or not (as with variable density thinning). Following is a description of these harvest methods. Other harvest methods are discussed at the end of this section.

► Variable Retention Harvest

Variable retention harvest is a type of regeneration, or stand-replacement harvest. In variable retention harvest, key structural elements of the existing stand are maintained while the commercial forest stand cohort is re-initiated (Franklin and others 1997). Retained cohorts may include snags, structurally unique and other leave trees, down wood, and other elements.

One aim of variable retention harvest is to create a favorable environment for the regenerating tree seedlings that represent the new commercial cohort. A favorable environment is one in which low levels of competition for light, water, and nutrients allows for rapid seedling establishment and growth. Site preparation, planting, and vegetation control activities may be conducted to ensure establishment and performance of the regenerated cohort.

Variable Retention Harvest in the OESF

Variable Retention Harvest in the OESF

The within-stand growing environment for trees regenerating after a variable retention harvest resembles an even-aged plantation, but with important differences. Because of DNR's conservation strategies and other policies (refer to Chapter 3), within the harvest boundary DNR also retains large, live trees; streamside forests; northern spotted owl habitat; marbled murrelet habitat; forests on potentially unstable slopes, if the risk of conducting activities on them is high; forested wetlands and bogs; old growth; and unique habitats per the multispecies conservation strategy. The result should be a harvest that is often irregular in shape (refer to photo, above). For that reason, there may be more within-stand competition with a variable retention harvest than

with a clearcut. Depending on the level of retention and the edge density (proportion of the amount of area to the length of the edge), competition from adjacent overstory trees in the immediate growing environment around the seedling may range from virtually none (similar to a clearcut) to high levels (similar to a multi-aged stand). Regenerating trees may grow at different rates depending on their location in the stand.

In stands with small opening sizes and high edge density, DNR is likely to use natural regeneration instead of replanting because of the abundance of natural seed sources of desirable tree species, the high level of competition due to retained trees, or the difficulty of applying a site preparation treatment. However, depending on objectives, replanting may be prescribed by the forester.

► Variable Density Thinning

Thinning involves selective removal of trees from a forest stand to reduce stand density and achieve stated objectives. Thinning redistributes growth from trees that do not contribute to objectives, to those that do. Thinning improves the growth of the retained trees, enhances stand health, and reduces tree mortality. After all types of thinning, one or more future commercial cohorts remain in the previous, dominant canopy (DNR 2009).

Variable Density Thinning in the OESF
Standing in thinned area looking toward a forest opening

A *variable density thinning* is a commercial activity used to accelerate stand development towards a stated objective. The objective is often a more complex stand structure: variable density thinning is often used to emulate characteristics of stand-level heterogeneity that research indicates would develop as trees grow and differentiate under natural or unmanaged conditions. When applied to stands in the Competitive Exclusion stage, a variable density thinning can introduce a substantial level of horizontal and vertical diversity that otherwise might take decades to develop. A variable density thinning also may be applied to more complex stand developmental stages to enhance their duration or promote specified cohorts. Variations in stand density cause trees to grow differently across the stand, with the outcome being greater within-stand diversity of structure, density, and tree sizes, species, and forms

(shapes). Knowing how trees respond to growing space allows the forester to target certain densities for specific objectives.

In variable density thinning:

- Foresters often create a mixture of small openings (gaps), un-thinned patches (skips), and varying stand densities to emulate the micro-scale disturbances that would occur naturally from snow, wind, disease, or other causes, given sufficient time.
- In areas where forest cover is retained, foresters may prescribe a thinning treatment including trees of all or most diameter classes that results in a mixture of healthy dominant, co-dominant, and understory trees. Thinning may be uniform across much of the treated area.
- Openings typically range from ¼ to 2 acres. Openings in the canopy can encourage natural regeneration of trees, growth and development of seedlings and saplings that have developed in the understory (in other words, advanced regeneration), and growth of understory shrubs and herbs. An assumed benefit is that these small openings, along with the general decrease in stand density that occurs through thinning, will increase growing space for retained trees along opening edges. Openings also serve as potential disturbance nuclei for wind and snow damage, thus contributing to the amount of down woody debris and snags and maintaining structurally distinct characteristics for longer periods than would otherwise occur.
- Variable density thinning introduces light into the stand, encouraging the stand to differentiate. For example, in heavily thinned areas, the stand may develop an understory. Differentiation increases structural diversity and often accelerates mortality through the expression of dominance, since larger trees typically out-compete smaller trees for necessary resources.
- Some areas may be skipped to allow for natural mortality, protect existing important structural features, and/or provide for other attributes of within-stand structural diversity or habitat.
- Variable density thinning may also include treatments to create large down wood and snags, or to target their development.
- Regeneration is not a primary objective. Natural regeneration may occur in openings and areas with lower residual density, potentially forming a lower canopy layer and bringing the stand into the Understory Development stand developmental stage.

Similar to a conventional thinning, a variable density thinning must have revenue objectives and financial thresholds to be operationally feasible.

The volume removed makes the thinning financially feasible, and the larger trees that may result from thinning may provide higher-quality timber in the future.

These Methods are not new

Neither variable retention harvest nor variable density thinning as practiced by DNR are new harvest methods. These methods have been developed and refined over the many years that DNR has been implementing integrated management in the OESF. Though they may seem routine today, they were revolutionary at the time they were developed.

As mentioned previously, when the OESF was established DNR was practicing clearcutting. Over the years, DNR began experimenting with new harvest techniques such as retaining biological legacies and reducing the size of forest openings. DNR also learned how to orient openings and arrange leave trees to minimize windthrow (windthrow is the blowing over or breaking of trees in the wind). Much of what has been learned and implemented in the OESF has since been adopted in other DNR planning units. Questions for future research may involve how to implement these complex harvest techniques more efficiently to ensure economically viable timber sales.

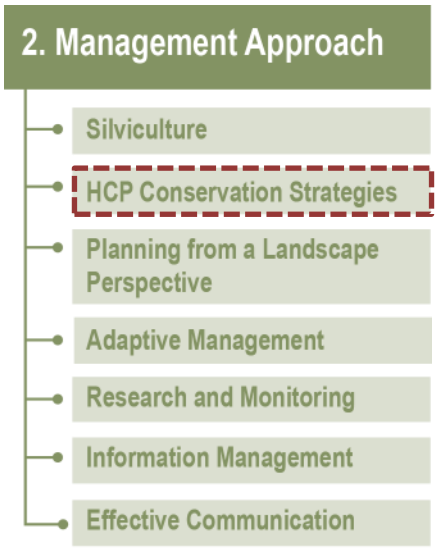
► Other Harvest Methods

The combination of unique site conditions and objectives means that no one harvest method works in all circumstances. To achieve revenue and ecological objectives, foresters planning a timber sale may use a variety of other harvest methods, such as selective product logging, in which only certain, highly valuable trees are removed from a stand, or uniform thinning, in which trees spacing after the thinning is fairly even. The final decision on which harvest method to use is based on numerous, interrelated factors and ultimately is made by the forester planning the sale.

Shovel Logging in the OESF

HCP Conservation Strategies

The HCP includes four major habitat conservation strategies for the OESF: northern spotted owl, riparian, marbled murrelet, and multispecies. Implementing these strategies across the OESF is another means by which DNR achieves a structurally and biologically diverse forest. Following, DNR describes each strategy and how it fits within the integrated management concept. More information on these strategies can be found in Chapter 3.



Northern Spotted Owl Conservation Strategy

Under the northern spotted owl conservation strategy, DNR restores and maintains a level of habitat capable of supporting northern spotted owls on DNR-managed lands in the OESF (DNR 1997, p. IV.86).

The HCP coined the term "unzoned" to describe its approach to northern spotted owl conservation, meaning "no special zones are set aside for either species conservation or commodity production" (DNR 1997 p. IV.81). Instead of designating specific areas on the land base as northern spotted owl habitat, DNR manages the OESF for a "shifting mosaic" of habitat.

DNR based this strategy on the landscapes identified under the 1991 Plan. In each of these 11 landscapes, DNR restores and maintains the following threshold proportions of northern spotted owl habitat: at least 40 percent of DNR-managed lands[1] as Young Forest Habitat and better, and at least 20 percent as Old Forest Habitat (habitat types will be described in Chapter 3). Habitat can be located anywhere within the landscape, and its location can shift over time: as one area matured into habitat, other existing areas of habitat can be harvested so long as threshold proportions of habitat are maintained.

Key features of this strategy include the following:

- Older forest is distributed throughout the forest mix (DNR 1997 p. IV.81) rather than concentrated permanently in one area.
- At any given point in time, any DNR-managed lands in the OESF can contribute toward habitat thresholds. By contrast, in other planning units DNR designates spotted owl management units (SOMU), usually near high-quality habitat on adjacent ownerships. SOMUs occupy only a portion of the overall planning unit; areas outside of the SOMUs have no role in northern spotted owl conservation.

The thresholds selected for the OESF are lower than the 50 percent threshold used in other HCP planning units. When the HCP was developed, DNR's literature search indicated that 30 to 50 percent habitat at spatial scales ranging from northern spotted owl ranges to landscapes was sufficient to support reproductive owl pairs (DNR 1997, p. IV.88). The 40 percent threshold was proposed for the OESF to allow managers and researchers greater flexibility in arriving at effective and efficient solutions to integrating revenue production and ecological values (DNR 1997, p. IV.88).

Riparian Conservation Strategy

Under the riparian conservation strategy, DNR protects, maintains, and restores habitat capable of supporting viable populations of listed, non-listed, and candidate species of salmonids and other species dependent on in-stream and riparian environments. DNR does this by placing interior-core buffers on streams, and by placing exterior wind buffers where needed to prevent windthrow in the interior-core buffer. This strategy also includes protection of wetlands and careful management of roads to prevent fine sediment delivery to streams.

The HCP acknowledged that riparian areas act "almost like zones" because they are linked to relatively fixed physical features on the landscape (DNR 1997, p. IV.81). However, to enable greater integration of revenue production and ecosystem values, management in riparian areas is tailored to the ecological condition of each watershed. For example, depending on watershed conditions DNR allows a small amount of regeneration harvest within interior-core buffers (refer to Chapter 3 for more information).

Because of the abundance of streams in the OESF, DNR anticipates that the riparian conservation strategy will result in complex, productive aquatic habitat in streams and wetlands, as well as late successional conifer forests along streams and on unstable slopes that could benefit aquatic, wetland, riparian obligate, and uplands species (DNR 1997, p.

IV.138). In fact, DNR's projections in the HCP showed that more than half of northern spotted owl habitat would be located in riparian areas (DNR 1997, p. IV.106). For that reason, the riparian and northern spotted owl conservation strategies are inter-dependent, and the patterns of habitat created through the intersection of these two strategies has have a bearing on the overall use of the landscape by northern spotted owls and other wildlife species.

Marbled Murrelet Conservation Strategy

At the time the HCP was written, DNR did not have enough information about marbled murrelet biology to write a long-term conservation strategy for marbled murrelets. Therefore the HCP included an interim strategy.

Under the interim strategy, DNR sets aside specific areas to protect the marbled murrelets and avoid foreclosing future options for management under a long-term strategy. DNR noted in the HCP that preservation of some marbled murrelet nesting habitat would increase the amount of late successional forest available to other species (DNR 1997, p. IV.138). Development of the long-term marbled murrelet conservation strategy currently is underway, and once completed will be integrated into this forest land plan.

Multispecies Conservation Strategy

The multi-species conservation strategy echoes the 1991 Plan's intent of non-species specific management (refer to Chapter 1). Although specific habitat types such as caves and balds are protected, habitat for most native species is envisioned as an outcome of landscape-level management in the OESF (DNR 1997, p. IV.137). For example, conservation measures for riparian areas and northern spotted owl and marbled murrelet habitat are expected to create interconnected patches of late-successional, mid-aged, and young forests (DNR 1997, p. IV.137) that support a range of species.

Planning from a Landscape Perspective

Planning from a landscape perspective is a multi-scale, multi-disciplined approach to planning that was recommended in the HCP as a means of implementing integrated management. This type of planning involves looking at the entire land base at different spatial scales to balance multiple objectives for revenue and ecological values, including the objectives of the four major habitat conservation strategies.

As well as knowledge and expertise in numerous disciplines such as wildlife biology, silviculture, forestry, forestry engineering, ecology, and hydrology, this type of planning requires powerful computer-based analytical tools. At this time, the tool most central to the planning process is a forest estate model called the "tactical model."

How the Tactical Model Works

The tactical model looks across the land base and decades to develop an "optimal solution" of where, when, and; by what method to harvest or not harvest to meet multiple objectives over time.

In the tactical model, all DNR-managed lands in the OESF are classified as either "operable" or "deferred." Operable areas are fully or partially available to the model for harvest (for example, thinning and variable retention harvest, or thinning only). By contrast, deferred areas are unavailable to the model for harvest.

Areas deferred from harvest in the tactical model include the following:

- Permanent deferrals, for example natural area preserves.
- Areas deferred from harvest per current DNR policies, such as old-growth forests. Areas deferred per DNR policies will remain deferred for as long as the policy that deferred them remains in place.
- Areas deferred in the model to represent current management practices and guidance, for example potentially unstable slopes or

landforms. DNR has guidance from both the forest practices rules and the HCP on preventing an increase in the frequency and severity of landslides. For those areas, DNR's conservative approach is to categorize them as deferred in the tactical model with the understanding that management decisions for those areas will be made on a case-by-case basis.

The number of acres deferred in the tactical model is fluid. For example, some areas may be incorrectly mapped as unstable and vice versa. Deferred areas are updated in the model each time the model is rerun.

The model also has access to "yield tables," which are projections of forest growth under "no management" and a variety of silvicultural regimes.[2] Yield tables are built with the forest vegetation simulator, a growth model developed by USFS.

The model's task is to find the optimal solution to maximize "net present value," meet ecological objectives, and stay within the bounds of current DNR policies. (Net present value is the cash inflow [revenue from timber sales] minus cash outflow [costs of forest management]). To develop its solution, the model sorts through the information in the yield tables to find the silvicultural regime for each area that best enables the model to meet its objectives.

As an example, consider the northern spotted owl conservation strategy. DNR's objective is to restore and maintain at least 40 percent of each landscape as Young Forest Habitat or better, and at least 20 percent as Old Forest Habitat. The model keeps track of the amount of habitat in each landscape currently, and the amount of habitat projected to develop over time. With this information, the model then develops a solution of which stands to harvest or not harvest over time to meet thresholds in each landscape while also maximizing net present value.

The model also performs a watershed assessment to determine how much harvest it can recommend in riparian areas while also riparian function, and how much harvest it can recommend in each Type 3 watershed without causing a detectable increase in peak flow (periods of high stream flow or maximum discharge, usually associated with storm events). The watershed assessment is described in Chapter 3.

The model provides two major types of outputs:

- A **harvest schedule**. The harvest schedule is the model's solution in list and map form. It recommends the types, locations, and timings of harvests.

- A **state-of-the-forest file**. The state of the forest file is a forecast of forest conditions (such as stand development) that are projected to occur as a result of implementing the harvest schedule.

How the Tactical Model is Used

The model is used as a planning tool to help DNR balance multiple objectives across the land base. **However, the model is only a tool and a guide; it is not meant to replace on-the-ground observation and decision making. Harvest and other management decisions *always* are based on actual, field-verified conditions.** Foresters use the harvest schedule provided by the model as a *starting point* for selecting an area to harvest. They begin each timber sale by doing an office review and field reconnaissance of the areas currently recommended by the model for harvest. Foresters consider costs, forest conditions, difficulty in harvesting and extracting the logs ("operability"), long-term objectives, and other factors. If the timber sale is feasible, it is implemented. During the implementation process, sale boundaries suggested by the model may be adjusted to accommodate unmapped streams, potentially unstable slopes, or other features. If the timber sale is not feasible, foresters may alter the sale or return to office review to select another area.

The Tactical Model Through Time

Deviations from the harvest schedule will occur as foresters plan and implement timber sales. As time passes, the effect of these deviations on the model's optimal solution may be compounded. To address this issue, DNR updates and re-run the model periodically. Factors that may trigger additional model runs include but are not limited to the following:

- **Operational needs**. Region managers may request a re-run of the model when needed to support operations.
- **Changes in the land base**, such as significant land acquisitions or transfers that would affect DNR's objectives, for example the balance of northern spotted owl habitat in a landscape.
- **Changes to the way DNR maps or models the stream network**.
- **Changes to DNR's northern spotted owl habitat definitions**, or changes in the way northern spotted owl habitat is represented in the model.
- **Changes to procedures** recommended through the adaptive management program, if those changes are likely to affect the harvest schedule.
- **Changes to underlying scientific assumptions** that affect how the model projects growth over time.
- **Changes to policies,** such as development of the long-term marbled murrelet conservation strategy.
- **Significant natural disturbances**, such as fire or windstorms.

Updating and rerunning the model will help keep DNR on track to meet its objectives and ensure that foresters have the most current information to help them with timber sale planning.

In addition, over time DNR expects to take advantage of technological and other advances to improve its modeling. These improvements may range from modification of the modeling framework to development of an entirely new tactical model using different software, to adoption of a different type of model that enables DNR to analyze management questions in new ways. Models used to develop the tactical model, such as the forest vegetation simulator, also may change.

Subsequent models will be built to represent current DNR policies as well as the integrated management approach and the strategies outlined in this forest land plan.

Adaptive Management

Adaptive management is a formal process for continually improving management practices by learning from the outcomes of operational and experimental approaches (Bunnel and Dunsworth 2009). The ultimate goal of this process is to improve the integration of revenue production and ecological values in the OESF.

The adaptive management process is focused on the forest management strategies DNR uses and the working hypotheses on which those strategies are based. The primary working hypothesis for the OESF is that it is possible to manage a working forest for both revenue production and ecological values. DNR breaks this broad, overarching hypothesis into primary hypotheses, which are then further distilled into specific hypotheses. For example, one of the primary working hypotheses for the riparian conservation strategy is that riparian conservation objectives can be met by placing buffers on streams. That hypothesis is broken into more specific hypotheses about the effectiveness of interior-core and exterior wind buffers.

Most management strategies are based on working hypotheses because of uncertainties (incomplete knowledge) about how forest conditions are

affected by management. DNR prioritizes uncertainties, reduces (learns about) them through research and monitoring, and determines whether the new information affirms or warrants a change in management.

Chapter 3 includes goals, objectives, and strategies for adaptive management. Refer to Chapter 4 for a detailed description of the adaptive management process and to the forestry handbook for the adaptive management procedure (PR 14-004-530, *Adaptive Management in the OESF HCP Planning Unit*).

Research and Monitoring

Research and monitoring is the primary means by which DNR gathers new information and reduce key uncertainties about the integrated management approach. Refer to Chapter 3 for goals, objectives, and management strategies, and Chapter 4 for a detailed description of this program.

Information Management

Information management includes collecting, managing, and sharing information and data between foresters, managers, planners, scientists, and others involved in implementing the integrated management approach.

Information management is critical to the success of integrated management for three primary reasons. First, implementing DNR's management strategies requires sophisticated models informed by up-to-date data. Second, assessing the success of these strategies, notably the strategies for riparian areas and northern spotted owl habitat, involves tracking both forest management activities and ecological conditions over time. And finally, the adaptive management process is critically dependent on effective information management. In order to "learn from doing," it is necessary to know what has been done and why.

Information management in the OESF is best described as a system with three major nodes. These three nodes include the following:

- **Land Resource Manager** (LRM). Formerly known as the planning and tracking database, LRM is a depository for all information pertaining to the day-to-day management of the OESF. In LRM, foresters record planned and completed silvicultural activities, including site preparation, planting, thinning, and regeneration harvest; sold products and timber volumes; and other information.

- **GIS layers**. GIS layers are DNR's data in spatial form, and include planned and completed timber sales, forest roads, stream location and type, potentially unstable slopes or landforms, habitat delineation, stands selected for thinning under the northern spotted owl conservation strategy, land ownership, and many other types of information.

- **Research and Monitoring Database**. The research and monitoring database is a depository of all current research projects being carried out in the OESF. The database includes detailed information such as principal investigators and cooperators, location, and a brief summary of the project, plus links to study plans and other documents.

Information flows between these three nodes constantly. For example:

- Foresters completing a timber sale enter all pertinent information for that sale into LRM.
- Information from LRM is used to update GIS layers, and both LRM and GIS layers are used to update the tactical model. The tactical model is used to produce an updated harvest schedule, which is then output into a GIS layer.
- Foresters use the updated GIS layers to plan their next timber sales.
- A research project is entered into the research tracking database and a polygon for that project is created on a GIS layer so foresters know where the project is. Foresters check this layer when planning timber sales.
- Information in LRM on completed timber sales also may be used to monitor compliance with HCP conservation strategies.

Because these systems are closely related, and because both GIS and LRM inform tactical model updates, keeping this information current is important. The success of information management also depends on standardized processes for data collecting and formatting and the flexibility to adapt and change these systems over time. Refer to the OESF Living Library for more information.

Effective Communication

Through effective communication, DNR builds public confidence in the sustainability of DNR's forest management practices and the effectiveness of its conservation strategies, and also engages in a dynamic exchange of ideas both internally and external to DNR. Effective communication is particularly vital to the success of DNR's adaptive management process.

Multiple formal and informal pathways are used to communicate with trust beneficiaries and other stakeholders, tribes, research partners, and the general public. Formal avenues include meetings of the Board of

Natural Resources, public meetings, and the State Environmental Policy Act (SEPA) checklists for timber sales. Less formal opportunities may exist for involvement in research and monitoring projects and for comments on research and monitoring reports and proposed management changes. Communication efforts may include workshops, an annual conference, a newsletter, articles in scholarly journals, magazines, and other publications. In addition, DNR provides information about the OESF in general and on research and monitoring projects on its website (www.dnr.wa.gov).

Effective communication also involves providing educational opportunities in the OESF. These opportunities include internships for undergraduate and graduate students, field trips for K-12 and college students, and lectures and presentations at colleges and universities. The topics covered in these activities range from specific ecological questions to descriptions of environmental monitoring and adaptive management. As funding allows, DNR will continue to support ongoing educational activities and envisions providing additional opportunities such as summer education programs and job shadowing for students in natural resource management field.

Response to Natural Disturbances

In the OESF, DNR protects trust assets from natural disturbances such as fire, wind, insects, and tree disease epidemics by creating and maintaining a forested landscape that is biologically diverse and resilient, as healthier forests are less likely to experience catastrophic losses (DNR 2006). DNR also considers windthrow risk when planning and implementing timber sales.

However, DNR cannot protect state trust lands from all natural disturbances. Small losses due to wind, disease, and other disturbances are natural and expected and accounted for in a general way in DNR's model projections. Such losses can support DNR's ecological objectives, for example by increasing structural diversity and providing large woody debris to stream.

DNR also cannot predict nor account for losses due to catastrophic storms that affect large areas. The historical record shows 14 storms of hurricane-strength winds on the coast in the last 200 years; two storms had winds in excess of 150 miles per hour (Henderson and others 1989,

Mass 2008). Examples of major windstorms that have affected the OESF include the following:

- The Great Olympic Blowdown on January 21, 1921, which felled an estimated 20 percent of the timber along the entire Olympic Peninsula coastline (Mass 2005);
- The Columbus Day Storm on October 12, 1962, in which hurricane-force winds along the coast blew down an estimated 15 million board feet of timber in Washington and Oregon (Mass 2005); and
- The Inauguration Day Storm of January 20, 1993 with winds over 80 miles per hour to the Washington coast and over 100 miles per hour to exposed sites in the coastal mountains and Cascades (Mass 2005).

When in the best interest of the trusts, DNR salvages forest stands that have been materially damaged by fire, wind, insects, or disease (DNR 2006). Currently, for natural disturbance events in northern spotted owl habitat DNR follows salvage guidelines in the 2006 Settlement Agreement[3], which will remain in place until the sustainable harvest calculation for the 2015 through 2024 sustainable harvest planning decade has been approved by the Board of Natural Resources. For salvage in other areas, DNR follows the catastrophic loss policy in the *Policy for Sustainable Forests*, RCW 79.15.210, RCW 79.15.220, and WAC 296-54, which addresses worker safety.

Once the 2006 Settlement Agreement has expired, DNR will follow a new procedure (currently in development) for salvage harvest after natural disturbance events. DNR also is developing new guidelines for salvage in marbled murrelet habitat as part of the marbled murrelet long-term conservation strategy, currently in development. Once the long-term strategy has been completed and approved, DNR will follow the guidance in the long-term strategy for salvage in marbled murrelet habitat.

Adaptation to Climate Change

Climate change is a change in average temperature and weather patterns that occurs on a regional or global scale over decades to centuries. Climate change is closely linked to a global rise in temperature, often referred to as global warming (Ecology 2011).

In Washington, the anticipated impacts of climate change may include warmer temperatures, reduced snowpack, increased frequency of extreme weather events, and a rise in sea level (Ecology 2011, USFWS 2011). These changes could shift the upper elevation range limits of tree species (Halofsky and others 2011); cause larger, more intense fires (Running 2006); and increase tree mortality (vanMantgem and others 2009). For a summary of how climate change could affect the forests of the OESF and the wildlife they support, refer to Chapter 3 of the final environmental impact statement for this forest land plan, which is listed under "documents" in the living library.

Although numerous studies have been completed to date, the exact timing, severity, and local effects of climate change are still uncertain. Given these uncertainties, it is also difficult to predict exactly how and when the forest will respond to changing conditions. What *is* certain, is that change will occur.

DNR will meet these challenges by creating and maintaining a biologically diverse forested land base. DNR also will continue following current policies on forest health and resilience, catastrophic loss prevention, and genetic resources. Information gathered through research and monitoring, particularly information that explores links between management and ecological conditions, may help inform future adaptation strategies. DNR has an adaptive management process in place to consider, select, and implement changes in management.

DNR also participates in climate change research, either through direct involvement or contribution of funding, supplies, and test sites. For example, DNR has been involved in studies examining how climate change may affect Douglas fir.

As a prudent trust lands manager, DNR manages its forests to "conserve and enhance the natural systems and resources of forested state trust lands….to produce long-term, sustainable trust income, and environmental and other benefits for the people of Washington" (DNR 2006, p. 3). DNR is fully committed to this goal, and will continue to examine its policies, procedures, and strategies as needed in the future to make sure the OESF continues to thrive as conditions change.

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[1] DNR uses the term "DNR-managed lands" instead of state trust lands because northern spotted owl habitat in natural resources conservation areas and natural area preserves contributes toward habitat thresholds. DNR is given credit for the habitat contributions provided by these lands in terms of meeting the conservation objectives of the HCP (DNR 1997, p. I.5).

[2] In the tactical model, silvicultural regimes are based on a limited number of silvicultural activities such as thinning and stand replacement harvest; other necessary activities such as planting and vegetation management are assumed to occur. Actual silvicultural regimes are more comprehensive and detailed.

[3] Washington Environmental Council et al. v. Sutherland et al. Settlement Agreement (King County Superior Court No. 04-2-26461-8SEA, dismissed April 7, 2006). This agreement expires, in total, with adoption of a sustainable harvest level for the next decade (fiscal years 2015-2024).

3

Goals, Objectives, and Management Strategies

For generating revenue and implementing the conservation strategies and research, monitoring, and adaptive management.

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Goals, Objectives, and Management Strategies

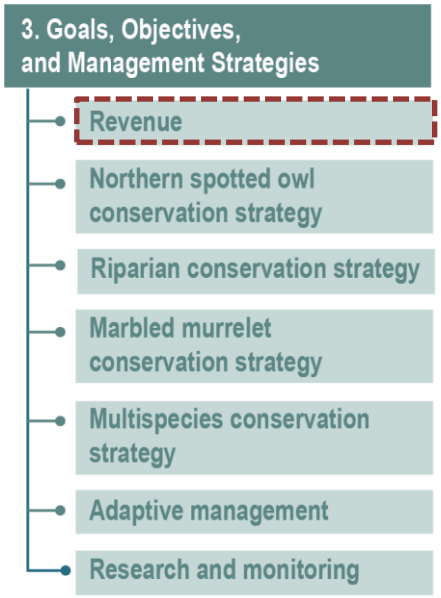
This chapter provides foresters and managers the practical direction and guidance they need to implement the integrated management approach on a day-to-day basis.

Direction and guidance in this chapter includes goals, measurable objectives, and management strategies for the production of revenue for trust beneficiaries, implementation of the four major HCP conservation strategies (northern spotted owl, riparian, marbled murrelet, and multispecies), and implementation of the research and monitoring and adaptive management programs. For the riparian, northern spotted owl, and multispecies conservation strategies, DNR also provides the working hypotheses on which the management strategies are based. A graphic is provided at the beginning of each section to help readers navigate this chapter.

Implementation procedures pertinent to this forest land plan can be found in the Forestry Handbook on DNR's intranet.

Revenue Production

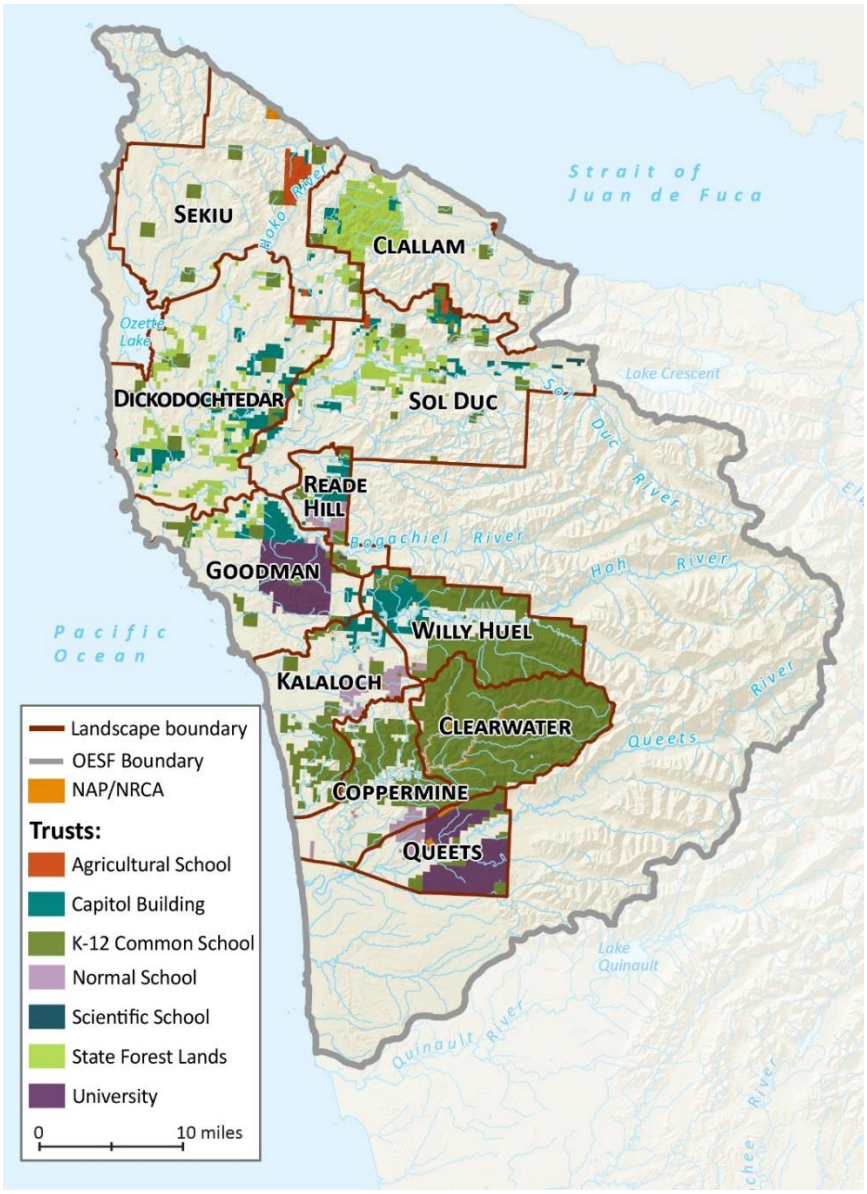
As a trust lands manager, DNR has a fiduciary responsibility to provide a sustainable flow of revenue to its trust beneficiaries. This revenue funds schools, hospitals, fire districts, universities, and other critical needs for local communities and statewide agencies. Following is a list of the trusts that benefit from harvest in the OESF.



- **K-12 Common School trust**: These trust lands support the construction of public kindergarten through twelfth-grade public schools throughout the state.
- **State Forest Land trust**: These trust lands (transfer and purchase) supports schools as well as county services including roads, libraries, fire districts, ports, hospitals, and emergency management.
- **Scientific and Agricultural School trusts**: These trust lands support construction at Washington State University.
- **Normal School trust**: These trust lands support construction at Eastern Washington, Western Washington and Central Washington universities and the Evergreen State College.
- **Capitol Building trust**: These trust lands support construction of state office buildings at the Capitol Campus in Olympia.
- **University trust**: These trust lands support construction at the University of Washington.

Map 3-1 on the following page shows the location of state trust lands managed under each trust, and Table 3-1 lists the acres of state trust lands in each trust.

Map 3-1. State Trust Lands in Each Landscape Managed Under Each Trust[a]



[a]Some trusts are not shown on this map because their acreage is too small to be visible at this spatial scale.

Table 3-1. Acres of State Trust Lands in Each Trust (Current as of 2016)*

Trust	Acres
Agricultural School	4,235
Capitol Building	30,474
K-12 Common School	149,458
Normal School	12,564
Scientific School	605
State Forest Lands	42,617
University	29,010

*This chart shows state trust lands only; totals do not include administrative sites, natural area preserves, or natural resources conservation areas.

The following goal, measurable objective, and strategies are based on p. 28 through 30 of the *Policy for Sustainable Forests*.

Goal:

Provide revenue for trust beneficiaries primarily through the harvest of timber.

Measurable Objective:

Harvest a volume of timber that is consistent with the current sustainable harvest level for the OESF.

Management Strategies:

- Calculate a decadal sustainable harvest level (RCW 79.10.300) and periodically adjust it.
- Manage the OESF as a single sustainable harvest unit regardless of trust.
- Keep annual harvest volumes within 25 percent (higher or lower) of the annual sustainable harvest level (the annual sustainable harvest level is the decadal sustainable harvest level divided by 10).
- Pursue opportunities for financial diversification.

How is the Objective Measured?

To measure its progress in meeting harvest volume targets, DNR compares total sold timber volume to the sustainable harvest level on a

continual basis. Volume is tracked using in-house accounting systems and updated each time a timber sale is sold. This accounting is done for all sustainable harvest units, including the OESF, and is reported in DNR's annual reports.

DNR takes advantage of financial diversification opportunities as they arise. Revenue from non-timber sources is listed each year in DNR's annual report.

How are the Management Strategies Implemented?

►Management Strategy: Calculate a Sustainable Harvest Level and Periodically Adjust it

The decadal sustainable harvest level is the volume of timber to be scheduled for sale from state trust lands during a planning decade as calculated by DNR and approved by the Board of Natural Resources (RCW 79.10.300). It represents the amount of timber that can be harvested from state trust lands sustainably in the framework of current laws and DNR policies.

The decadal sustainable harvest level is recalculated at the end of each planning decade, although DNR may recalculate more often when needed to accommodate new legal, economic, environmental, or other considerations. Because the sustainable harvest level is a policy decision, the level is adopted by the Board of Natural Resources.

To ensure intergenerational equity, DNR requires each decadal sustainable harvest level to fall within 25 percent (plus or minus) of the preceding decade's level (DNR 2006, p. 29). Intergenerational equity means a fair and equitable distribution of the harvest across decades to avoid favoring one generation of trust beneficiaries over another. In calculating the level, DNR looks ahead as many as 10 decades to ensure enough timber is available in subsequent decades to meet this requirement.

►Management Strategy: Manage the OESF as a Single Sustainable Harvest Unit Regardless of Trust

Each decade, DNR adopts a separate decadal sustainable harvest level for each of 20 sustainable harvest units. One of these units is the OESF. The decadal sustainable harvest level for the OESF applies to all state

trust lands in the unit *as a whole*. The decadal sustainable harvest level for the OESF is not broken into separate levels or targets for individual trusts or geographic areas such as landscapes.

►Management Strategy: Keep the Annual Mean Volume Within 25 Percent (Higher or Lower) of the Decadal Mean Volume

DNR's policies on sustainable harvest are designed to produce reliable revenue to trust beneficiaries while still providing enough flexibility to respond to changes in timber markets, natural disturbance, economic conditions, and other factors.

Per the *Policy for Sustainable Forests*, during each year of the planning decade a sustainable harvest unit's total sold timber volume may be as much as 25 percent higher or lower than the annual sustainable harvest level, so long as the decadal level is sustained over the decade. DNR tracks total sold timber volume against annual and decadal sustainable harvest levels on a continual basis and adjusts timber sales as necessary to stay on track.

►Management Strategy: Pursue Opportunities for Financial Diversification

Financial diversification is an important fiduciary consideration for meeting DNR's trust obligations (DNR 2006). DNR prudently pursues economic opportunities related to ecological and social benefits that flow from forested state trust lands to improve the net revenue from forestlands (DNR 2006). For example, DNR offers and manages leases for special forest products such as salal, evergreen huckleberry, sword fern, and moss.

Timber Harvest in the OESF

Northern Spotted Owl Conservation Strategy

The northern spotted owl was listed as threatened under the Endangered Species Act in 1990. The listing was due to widespread loss and adverse modification of suitable habitat across its geographic range, and the inadequacy of existing regulatory mechanisms to conserve the owl.

A federal recovery plan for the northern spotted owl was completed by USFWS in 2011 (USFWS 2011b). DNR supports federal recovery objectives for the owl by providing habitat that makes a significant contribution to demographic support, maintenance of species distribution, and facilitation of dispersal on DNR-managed lands in the OESF (refer to Chapter 5 for definitions of these terms). For a description of northern spotted owl biology, refer to Chapter 3 of the HCP.

The following goals, measurable objective, and strategies are based on p. IV.86 through IV.88 of the HCP.

Goals:

- Develop and implement a forest land plan that does not appreciably reduce the chances for survival and recovery of the northern spotted owl sub-population on the Olympic Peninsula.

- Develop, implement, test, and refine management techniques for stand-level forest management that integrate older forest ecological values, including the stand's function as dispersal, foraging, roosting, and nesting habitat for northern spotted owls, with revenue objectives for those stands.

- Develop, implement, test, and refine landscape-level forest management techniques that support a wide range of forest ecological values in a working forest, including their occupancy by successfully reproducing northern spotted owls that are a functional segment of the Olympic Peninsula sub-population.

Measurable Objective:

Restore and maintain the following threshold proportions of Young and Old Forest Habitat in each of the 11 landscapes in the OESF:

- At least 40 percent (by area) of DNR-managed lands in each landscape as Young Forest Habitat and better (Young Forest or Old Forest Habitat).
- At least 20 percent of DNR-managed lands in each landscape as Old Forest Habitat.

These thresholds are not additive. DNR restores and maintains at least 40 percent of each landscape as northern spotted owl habitat; of that amount, at least 20 percent should be Old Forest Habitat.

Management Strategies and the Working Hypotheses on Which They are Based:

The primary working hypothesis for the northern spotted owl conservation strategy is that DNR can meet its goals for revenue production and northern spotted owl habitat conservation in the OESF by maintaining threshold proportions of northern spotted owl habitat in each landscape. This primary working hypothesis is also broken down into specific working hypotheses. Table 3-2 lists the management strategies and the specific working hypotheses on which they are based.

Table 3-2. Northern Spotted Owl Habitat Management Strategies and Specific Working Hypotheses

Management Strategy	Specific Working Hypothesis
Manage for Young and Old Forest Habitat.	HCP definitions for Young and Old Forest Habitat describe habitat that supports the life history requirements of northern spotted owls.
Maintain and restore threshold proportions of Young Forest and Old Forest Habitat in each of the 11 landscapes of the OESF.	Threshold proportions of habitat are adequate to maintain successfully reproducing northern spotted owls, *and* the spatial distribution of northern spotted owl habitat across the 11 landscapes of the OESF will support successfully reproducing northern spotted owls.
Create and maintain habitat through active management.	Silvicultural treatments in forest stands will create habitat with the quality and at the rate expected in the HCP, *and* northern spotted owls will respond as expected in the HCP to habitat created or maintained through active management.

How is the Objective Measured?

DNR tracks the amount of existing northern spotted owl habitat in each of the 11 landscapes to determine progress toward meeting thresholds. Once per year, DNR reports to the Federal Services (NOAA Fisheries and USFWS) the number of acres of habitat in each landscape and the percentage of each landscape that is currently Young or Old Forest Habitat. For information on how DNR models and tracks habitat, refer to the OESF Living Library on DNR's intranet.

How are the Management Strategies Implemented?

►Management Strategy: Manage for Young and Old Forest Habitat

Young Forest Habitat is defined as forests that meet the structural definitions of sub-mature and young forest marginal habitat. Young Forest Habitat supports dispersal and provides some opportunities for roosting and foraging. Old Forest Habitat is defined as forests that meet the structural definitions of high quality nesting habitat, Type A habitat, and Type B habitat. Old Forest Habitat supports all of the owl's needs, including nesting.

The HCP definitions of northern spotted owl habitat (p. IV.11 through IV.12) list the structural attributes a forest stand must have to be considered habitat. DNR has translated those attributes into specific, numeric queries, for example a minimum number of trees per acre. DNR applies these queries to its forest inventory data to determine if a stand meets habitat definitions. Both the habitat definitions and their numeric queries are shown in Tables 3-3 and 3-4. Through research, monitoring, and adaptive management, the habitat definitions and the queries used to identify them may change over time.

Table 3-3. Young Forest Habitat Definition and Numeric Queries Applied to Forest Inventory Data

Sub-mature Habitat	
Definition	**Numeric queries**
• Forest community dominated by conifers, or in mixed conifer/hardwood forest; the community is composed of at least 30 percent conifers • At least 70 percent canopy closure	• 30 percent or more conifer trees per acre • Curtis's relative density ≥ 48 • 115 to 280 trees per acre >4 inches diameter at breast height (DBH) class

• Tree density between 115 and 280 trees greater than 4 inches DBH per acre • Trees over 85 feet tall • At least three snags per acre that are at least 20 inches in diameter • At least 5 percent groundcover of down wood	• Minimum top height of 40 largest trees >85 feet tall • At least 3 snags per acre >20 inches DBH and 16 feet tall • At least 2,400 cubic feet per acre down wood
Young Forest Marginal	
Definition	**Numeric queries**
• Forest community dominated by conifers, or in mixed conifer/hardwood forest, the community is composed of at least 30 percent conifers • At least 70 percent canopy closure • Tree density between 115 and 280 trees greater than 4 inches DBH per acre • Trees over 85 feet tall • At least two snags per acre that are at least 20 inches in diameter or equal to 10 percent of the ground covered with 4 inch diameter or larger down wood with 25 to 60 percent shrub cover	• 30 percent or more conifer trees per acre • Curtis's relative density ≥48 • 115 to 280 tree per acre >4" DBH • Minimum top height of 40 largest trees >85 feet tall • At least 2 snags per acre >20 inches DBH and 16 feet tall or at least 4,800 cubic feet per acre down wood

Table 3-4. Old Forest Habitat Definition and Numeric Queries Applied to Forest Inventory Data

High Quality Nesting	
Definition	**Numeric queries**
• At least 31 trees per acre greater than or equal to 21 inches DBH with at least 15 trees, of those 31 trees, per acre greater than or equal to 31 inches DBH • At least three trees, from the above group of 31 trees, have broken tops • Canopy closure at least 70% • At least 12 snags per acre larger than 21 inches DBH • A minimum of 5 percent ground cover of down wood	• At least 3 live trees per acre >21 inches DBH with broken tops • At least 16 trees per acre >21 inches DBH • At least an additional 15 trees per acre >31 inches DBH • Minimum top height of 40 largest trees >85 feet tall • Curtis's relative density ≥48 • At least 12 snags per acre ≥21 inches DBH • At least 2,400 cu feet per acre down wood
Type A Habitat	
Definition	**Numeric queries**
• A multi-layered, multispecies canopy dominated by large (30 inches diameter or greater) overstory trees (typically 15 to 75 trees per acre)	• At least 2 canopy layers with at least 2 tree species • At least 20% of trees per acre in minor species

• At least 70 percent canopy closure • A high incidence of large trees with various deformities such as large cavities, broken tops, and dwarf mistletoe infection. • At least two snags per acre that are at least 30 inches in diameter or larger • Large accumulation of fallen trees and other down wood on the ground	• Canopy typically dominated by 75 to 100 trees per acre >20 inch DBH • Curtis's relative density ≥ 48 • At least 2 live trees per acre >21inches DBH with broken tops • Two or more snags per acre >30 inches DBH and 16 feet tall • At least 2,400 cubic feet per acre down wood
Type B Habitat	
Definition	**Numeric queries**
• Few canopy layers, multispecies canopy dominated by large (greater than 20 inches diameter) overstory trees (typically 75 to 100 trees per acre, but can be fewer if large trees are present) • At least 70 percent canopy closure • Some large trees with various deformities • Large (greater than 20 inches diameter) snags present • Large accumulation of fallen trees and other down wood on the ground	• At least 2 canopy layers with at least 2 species • At least 20% of trees per acre in minor species • Canopy typically dominated by 15 to 75 trees per acre >30 inches DBH • Curtis's relative density ≥48 • Large trees with various deformities • At least 1 live tree per acre > 21 inches with broken top • One or more snags per acre >20 inches DBH and 16 feet tall • At least 2,400 cubic feet per acre down wood

►Management Strategies: Maintain and Restore Threshold Proportions of Young Forest and Old Forest Habitat in Each of the 11 Landscapes of the OESF *and* Create and Maintain Habitat Through Active Management

The northern spotted owl conservation strategy is based on the concept of a "shifting mosaic" of habitat. Instead of designating permanent areas in the OESF as northern spotted owl habitat, DNR maintains threshold proportions of habitat in each landscape (40 percent Young Forest Habitat and better, and 20 percent Old Forest Habitat). As one area in a landscape matures into habitat, another can be harvested so long as threshold proportions are maintained.

Northern spotted owl habitat can be located anywhere on forested state trust lands within the 11 landscapes, including areas being managed under the other conservation strategies. For example, marbled murrelet habitat also may be northern spotted owl habitat and vice versa. The riparian conservation strategy also was expected to contribute to northern spotted owl habitat thresholds. At the time the HCP was written, preliminary analysis showed that roughly 20 percent of mid-aged forests were located near stream channels or on potentially unstable slopes or landforms, and an additional 10 percent were in potentially wind-prone areas near streams (DNR 1997, p. IV.103). DNR has identified uncertainties regarding the contribution these areas make toward northern spotted owl habitat conservation (refer to "Research and Monitoring" in Chapter 4 for information on uncertainties).

The northern spotted owl conservation strategy is implemented in two phases, the restoration phase and the maintenance and enhancement phase. The restoration phase is the time it takes a landscape to attain the 40 percent Young Forest Habitat and better threshold.[1] The maintenance and enhancement phase is the time between attainment of the 40 percent threshold and the end of the HCP permit period (2067).[2] The 20 percent Old Forest Habitat threshold can be met in either phase. The length of each phase differs from one landscape to the next; one landscape may be in the restoration phase while another enters the maintenance and enhancement phase. Following, DNR describes management in each phase.

The Restoration Phase

To help meet northern spotted owl habitat thresholds, DNR applies management pathways to each landscape. Pathways are primarily applied during the restoration phase, although they may be extended into the maintenance and enhancement phase if needed.

A pathway is a course of action to achieve the following:

- Attain threshold proportions of northern spotted owl habitat in each landscape more quickly than anticipated in the HCP when possible.
- Increase habitat patch size where possible.
- Where feasible, create or accelerate habitat in deferred areas to take full advantage of these areas.

Most pathways involve selecting forest stands as candidates for active or passive management. Active management means selected forest stands will be thinned to create or accelerate the development of northern spotted owl habitat. Passive management means the stand will not be thinned or regenerated for as long as the pathway remains in effect (most likely, until the end of the restoration phase), although habitat

enhancement projects may still occur (such as creation of snags or down wood). Forest stands selected for active or passive management under the pathways are referred to as "candidate stands."

To understand how the pathways work, consider the following:

- In one landscape, DNR may find that some forest stands in deferred areas are close to becoming Young Forest Habitat. Those same forest stands may be located near adjacent habitat on federal lands. By thinning these stands, DNR may speed attainment of habitat thresholds in the landscape, shift the location of habitat away from operable areas, and create larger patches of habitat. The pathway for this landscape would be "select candidate stands of non-habitat in deferred areas for active management." Once the pathway for the landscape was determined, DNR would select specific forest stands within the landscape that are good candidates for thinning.

- In another landscape, some existing stands of Young or Old Forest Habitat may be located in areas that are inaccessible for timber harvest. Those same stands may be located near northern spotted owl habitat on adjacent federal lands, creating opportunities to maintain patch size. The pathway for this landscape would be "select candidate stands of Young or Old Forest Habitat in operable areas for passive management." Once the pathway for the landscape was determined, DNR would select those specific forest stands within the landscape to be managed passively (not harvested).

Pathways are selected based on numerous, inter-related factors such as forest conditions, availability of stands suitable for thinning, location of habitat, and percent of the landscape deferred from harvest. For each landscape, DNR selects and applies one or more pathways for achieving the 40 percent Young Forest Habitat and better threshold and one or more pathways for achieving the 20 percent Old Forest Habitat threshold.

Candidate stands selected under the pathways are integrated into the tactical model, such that the model knows:

- Which forest stands of existing northern spotted owl habitat have been selected for passive management through the pathways, and

- Which forest stands of non-habitat have been selected for active management through the pathways.

Given this information, the tactical model looks across the landscape to determine which *additional* stands it needs to meet thresholds. These additional stands could be stands that are habitat now, or stands that are projected to develop into habitat in the future. The tactical model uses

this information to develop its optimal solution of which forest stands to harvest or not harvest to meet its revenue and ecological objectives.

Thus, in a given landscape habitat thresholds will be met with a combination of the following, depending on the pathway(s) and candidate stands selected for the landscape:

- Existing habitat selected for passive management through the pathways,
- Non-habitat selected for active management through the pathways, *and*
- Additional forest stands of current or future habitat selected by the model to meet habitat thresholds.

Pathways

Currently, there are eight pathways. Following is a description of each pathway, organized by the major type of management involved. Over time, DNR may adjust these pathway definitions. The intent of the pathways—selecting candidate stands for active or passive management—will not change, but some pathways may be combined for ease of modeling and planning.

Model's Optimal Solution Pathways

- **Pathway 1**: Allow tactical model to develop its optimal solution without any specific stand selected for active or passive management to meet the 40 percent Young Forest Habitat and better threshold
- **Pathway 2**: Allow tactical model to develop its optimal solution without any specific stand selected for active or passive management to meet the 20 percent Old Forest Habitat threshold.

Under these pathways, DNR does not designate specific forest stands in the model for passive or active management to meet habitat thresholds. Instead, DNR allows the model to develop its optimal solution without such designations in place. This choice is appropriate for landscapes in which a) the landscape has already achieved one of the thresholds; b) limited opportunities exist for speeding attainment of thresholds, increasing patch size, or creating habitat or accelerating habitat development in deferred areas; or c) a combination of both. For example, the Reade Hill landscape has already met the 20 percent Old Forest Habitat threshold and is close to meeting the 40 percent Young Forest Habitat Threshold.

Passive Management of Young or Old Forest Habitat

- **Pathway 3**: Select candidate stands of Young or Old Forest Habitat in operable areas for passive management to help meet the 40 percent Young Forest Habitat and better threshold.
- **Pathway 4**: Select candidate stands of Young or Old Forest Habitat in operable areas for passive management to help meet the 20 percent Old Forest Habitat threshold.

Technically, all existing habitat needed to meet thresholds in each landscape is passively managed during the restoration phase. Under this pathway, however, DNR selects stands of existing habitat in operable areas that it wants to ensure are passively managed during the restoration phase to provide added certainty on attaining habitat thresholds.

Stands are selected based on numerous considerations. For example, DNR may select habitat that is adjacent to or near existing high-quality habitat on state trust lands or federal lands, to preserve patch size. DNR may select stands of Young Forest Habitat that are close to attaining Old Forest Habitat conditions to potentially speed attainment of the 20 percent Old Forest Habitat threshold. Or, DNR may consider a stand's operability. Hard-to-reach stands in areas unlikely to be harvested may best be left as habitat during the restoration phase.

Active Management of Non-habitat

- **Pathway 5**: Select candidate stands of non-habitat in operable areas for active management (thinning) to help meet the 40 percent Young Forest Habitat and better threshold.
- **Pathway 7**: Select candidate stands of non-habitat in deferred areas for active management (thinning) to help meet the 40 percent Young Forest and Better threshold.

In both operable and deferred areas, DNR targets non-habitat that is most likely to respond well to thinning. For example, DNR may select candidate stands that have many attributes of Young Forest Habitat already but have too many trees per acre to meet habitat definitions. In selecting candidate stands, DNR also considers patch size and proximity to existing northern spotted owl habitat on DNR-managed lands or adjacent federal lands. Where opportunities exist, DNR selects non-habitat in deferred areas to encourage habitat to develop in deferred versus operable areas.

These pathways reflect the intent of the HCP, which states that when and where feasible, harvest and other silvicultural activities in young stands should promote the development of Young or Old Forest Habitat, such that the restoration phase is expedited (DNR 1997, p. IV.99).

Active Management of Young Forest Habitat

- **Pathway 6**: Select candidate stands of Young Forest Habitat in operable areas for active management to help meet the 20 percent Old Forest Habitat threshold.

- **Pathway 8**: Select candidate stands of Young Forest Habitat in deferred areas for active management to help meet the 20 percent Old Forest Habitat threshold.

To date, DNR has not selected or applied either of these pathways to any landscape in the OESF. However, thinning of Young Forest Habitat may occur outside of these pathways in any landscape. Refer to "Other Management Activities During the Restoration Phase" later in this section for more information.

Table 3-5 lists the pathways currently applied to each landscape. Over time, DNR may adjust pathway selections as conditions in the OESF change. Land transfers, natural disturbance, updated mapping, and other factors can affect the choice of pathway. The tactical model is rerun each time the pathways are adjusted.

Table 3-5. Pathways in Each Landscape

Landscape	40 Percent Young Forest and Better Pathway	20 Percent Old Forest Pathway
Clallam	1 (model's optimal solution)	4 (passive management of Young or Old Forest Habitat, operable areas)
Clearwater	7 (active management of non-habitat , deferred areas)	2 (model's optimal solution)
Coppermine	7 (active management of non-habitat , deferred areas)	2 (model's optimal solution)
Dickodochtedar	1 (model's optimal solution)	4 (passive management of Young or Old Forest Habitat, operable areas)
Goodman	5 (active management of non-habitat, operable areas) and 7 (active management of non-habitat , deferred areas)	2 (model's optimal solution)
Kalaloch	5 (active management of non-habitat, operable areas) and 7 (active management of non-habitat , deferred areas)	4 (passive management of Young or Old Forest Habitat, operable areas)
Queets	7 (active management of non-habitat , deferred areas)	2 (model's optimal solution)

Landscape	40 Percent Young Forest and Better Pathway	20 Percent Old Forest Pathway
Reade Hill	1 (model's optimal solution)	2 (model's optimal solution)
Sekiu	1 (model's optimal solution)	2 (model's optimal solution)
Sol Duc	3 (passive management of Young or Old Forest Habitat, operable areas)	4 (passive management of Young or Old Forest Habitat, operable areas)
Willy Huel	5 (active management of non-habitat, operable areas) and 7 (active management of non-habitat , deferred areas)	2 (model's optimal solution)

Implementing Active Management Under the Pathways

Candidate stands of non-habitat selected for active management (Pathways 5 and 7) in the current decade are shown on the harvest schedule. Not all candidate stands are thinned. Foresters evaluate all the candidate stands shown in the harvest schedule and determine which stands to thin based on numerous considerations such as forest conditions, accessibility, cost and budget priorities, and proximity to planned harvests. Multiple small candidate stands may be combined for more efficient operations. Before the activity takes place, foresters conduct field reconnaissance to verify the feasibility of conducting a thinning.

Under certain circumstances, some thinnings may be non-commercial (trees dropped and left in place instead of hauled to markets). For example, a stand may be inaccessible for haul routes, such as an isolated parcel surrounded by other ownerships. Or, it may be financially infeasible to build haul routes, meaning the cost of building or maintaining haul route would exceed potential revenue from the sale. Other reasons may include difficulties with topography, distance of the stand from potential landing sites, or other issues.

Candidate stands selected for non-commercial thinning may be funded through DNR's budget for silvicultural activities or by other means such as grants, partnerships, or capital funding. Candidate stands selected for commercial thinning in the next five years are included in the five-year timber sale schedule, which is discussed later in this section.

For any thinning on a potentially unstable slopes or landforms, whether that thinning is commercial or non-commercial, DNR follows the forest practices rules and guidance in Section 16 of the Forest Practices Board Manual to protect down-slope resources and public safety.

Other Management Activities During the Restoration Phase

Regeneration Harvest of Young Forest Habitat

During the restoration phase, existing Young Forest Habitat is not be available for regeneration harvest unless it can be demonstrated, through modeling or other means, that the harvest would not increase the length of the restoration phase for the landscape. For example, in some landscapes DNR's projections may show that by a certain decade the proportion of habitat in the landscape will exceed thresholds; in those cases, harvesting a portion of that habitat now would have little effect on when the landscape attains the 40 percent threshold. Such harvest also cannot occur until the 2006 Settlement Agreement has expired. Harvest of Young Forest Habitat during the restoration phase requires notification of DNR's HCP and Scientific Consultation Section before the harvest takes place.

Thinning of Young Forest Habitat

Young Forest Habitat is available for thinning if the thinning will maintain or improve the habitat's structural components such as down wood, snags, and large diameter trees. The stand must continue to meet the definition of Young Forest Habitat (Table 3-3), including a minimum Curtis' relative density of 48, after the thinning.

Regeneration or Thinning Harvest of Old Forest Habitat

Neither thinning nor regeneration harvest occurs in Old Forest Habitat during the restoration phase, except as part of peer-reviewed, DNR-approved research and monitoring projects.

Regeneration or Thinning Harvest of Non-Habitat

DNR conducts both commercial thinning and regeneration harvest of non-habitat stands during the restoration phase. These timber sales are included in the five-year timber sale schedule, along with the selected commercial thinnings under the pathways.

To develop the five-year timber sale schedule, foresters use the tactical model's optimal solution (expressed as a harvest schedule) for the current decade as a starting point. It is possible that foresters may deviate from the model's optimal solution. For example, foresters may find that an area the model has selected in the current decade is unsuitable for timber harvest due to unmapped streams, potentially unstable slopes or landforms, or other issues, and may exchange that area for another that was not recommended for harvest until a future decade. These deviations may affect habitat thresholds if the area the forester selects for harvest was being held by the model as future habitat.

To address this issue, DNR periodically runs the five-year timber sale schedule through the tactical model to see if (or how) the timber sale schedule would affect the attainment of habitat thresholds. If the timber sale schedule *does not* change the decade thresholds are attained, DNR implements the action plan. If it *does* affect the decade thresholds are attained, DNR adjusts the timber sale schedule accordingly.

Road and Other Auxiliary Operational Activities

During the restoration phase, in Young Forest Habitat or candidate stands DNR may perform the following, although such work should be limited to the greatest extent practicable: new road construction; tail holds; guy line circles; yarding corridors; road maintenance and abandonment plan-related work and other forest road maintenance such as grading, shaping, ditch cleanout, culvert replacement, road abandonment, and removal of brush and trees within the road prism and right-of-way; or other auxiliary operational activities.

These activities also can occur in Old Forest Habitat but should be limited to the greatest extent practicable. Foresters are required to notify the HCP and Scientific Consultation Section prior to implementing these activities in Old Forest Habitat.

The Maintenance and Enhancement Phase

Old Forest Habitat will continue developing to at least 20 percent of each landscape during the maintenance and enhancement phase. Once entered, the maintenance and enhancement phase remains in effect for the remainder of the HCP permit period (to 2067).

During this phase, DNR may harvest Young Forest Habitat so long as the 40 percent Young Forest and Better threshold is maintained. Once the 20 percent Old Forest Habitat threshold has been met, DNR may harvest Old Forest Habitat so long as that threshold is maintained. In both cases, "harvest" includes both thinning or stand replacement, and "maintained" means the amount of habitat in the landscape does not fall below threshold proportions. Harvest activities may be done for the purpose of enhancing ecological values, producing revenue, or both. However:

- Regeneration harvest of either Young or Old Forest Habitat cannot occur until the 2006 Settlement Agreement expires.
- The stand cannot be harvested if it is deferred (for example, an old-growth stand defined by PR 14-005-045).

DNR may harvest Old or Young Forest Habitat outside of these guidelines as part of DNR-approved, peer-reviewed research and monitoring projects.

Road and Other Auxiliary Operational Activities

During the maintenance and enhancement phase, in Young or Old Forest Habitat DNR may perform the following, although such work should be limited to the greatest extent practicable: new road construction; tail holds; guy line circles; yarding corridors; road maintenance and abandonment plan-related work and other forest road maintenance such as grading, shaping, ditch cleanout, culvert replacement, road abandonment, and removal of brush and trees within the road prism and right-of-way; or other auxiliary operational activities. Foresters are required to notify DNR's HCP and Scientific Consultation Section prior to building new roads through Old Forest Habitat.

What About Known Nest Sites?

Known northern spotted owl nest sites are located within Status 1 or 2 owl circles as documented in the WDFW state database. With adoption of the HCP, DNR transitioned from managing by owl circles to managing by habitat thresholds. However, DNR does not conduct harvest (thinning or regeneration) or road construction or reconstruction within the best-70 acre core (that may or may not be habitat) around known nest sites between March 1 and August 31 of each year. This guideline applies to both the restoration and the maintenance and enhancement phases. DNR retains these guidelines despite a drop in the number of northern spotted owls on DNR-managed lands in the OESF (refer to Text Box 3-1) and the high likelihood that known nest sites are not currently occupied by northern spotted owls.

Text Box 3-1. Current Status of Northern Spotted Owls in the OESF

Northern spotted owl populations have experienced range-wide declines, especially in the northern portion of their range including the Washington Cascades and Olympics. DNR monitoring on the Olympic Peninsula in the 1990s showed the abandonment of many nesting sites, such that only four sites remained occupied by the early 21st century and only one of those was still occupied by a pair of owls. DNR ceased comprehensive monitoring in 2002 because so few owls remained and because of other priorities for limited funds. Annual monitoring on federal lands documented similar, though less severe declines. (Based on WDFW databases and federal monitoring reports.)

Riparian Conservation Strategy

Under the riparian conservation strategy for state trust lands in the OESF, DNR protects, maintains, and restores habitat capable of supporting viable populations of salmonids and other species dependent on in-stream and riparian environments (DNR 1997, p. IV.107). The OESF riparian conservation strategy seeks to achieve this vision by conserving habitat complexity as afforded by natural disturbance regimes on the western Olympic Peninsula. Habitat complexity is defined as 1) variations in stream-flow velocity and stream depth created by structural obstructions to channel flow, 2) physical and biological interactions between a channel and its floodplain, 3) aquatic and riparian structures that provide cover from predators, 4) a variety of stream substrates that includes gravel for fish spawning and macro-invertebrate habitat, and 5) a diversity of riparian vegetation that provides adequate sources of woody debris and nutrients (such as leaf and needle litter) to channels and that moderates water temperature and microclimate within the riparian corridor (Bisson and others 1992 as cited in DNR 1997, p. IV.107).

A key principle of managing for habitat complexity is to focus on natural processes and variability, rather than attempting to maintain or engineer a desired set of conditions through time (Lugo and others 1999, Dale and others 2000 as cited in Bisson and Wondzell 2009). DNR does not intend to restore streams to a "desired future condition," but to **maintain or aid restoration of riparian functions** important to salmonid habitat. DNR believes that if it focuses on a subset of riparian functions and processes, it can indirectly provide for the full suite of riparian functions and processes to meet the habitat needs of salmon and other species dependent on in-stream and riparian environments. For example, if the riparian management zone is wide enough to provide large woody debris input at a natural background composition and rate, then it most likely will provide most of the required salmonid habitat protection (Washington Forest Practices Board [WFPB] Riparian Habitat Technical Committee 1985, United States Department of Agriculture [USDA] and

United States Department of the Interior [USDI] 1993; Cederholm 1994; as cited in DNR 1996).

DNR acknowledges that habitat complexity as afforded by natural disturbance regimes is difficult to quantify or target. Research is needed to interpret this concept in more practical terms and to demonstrate how riparian systems vary in space and time. The Status and Trends Monitoring of Riparian and Aquatic Habitat in the OESF project will help with this understanding (refer to Chapter 4 for information about this project).

DNR's goals, measurable objectives, and strategies are based on p. IV.107 through IV.108 of the HCP. These goals and objectives represent DNR's contribution to watershed health; in many watersheds, DNR manages only a portion of the watershed. DNR will describe, in a later section, how objectives will be measured.

Goals:

- Maintain or aid restoration of the composition, structure, and function of aquatic, riparian, and associated wetland systems which support aquatic species, populations, and communities.
- Maintain or aid restoration of the physical integrity of stream channels and floodplains.
- Maintain or aid restoration of water to the quantity, quality, and timing in which these stream systems evolved (the natural disturbance regime of these systems).
- Maintain or aid restoration of the sediment regimes in which these systems evolved.
- Develop, use, and distribute information about aquatic, riparian, and associated wetland-ecosystem processes and their maintenance and restoration in commercial forests.

Measurable Objectives:

- Maintain or aid restoration of the potential of riparian forests to provide large woody debris to the stream channel. Large woody debris recruitment refers to logs, pieces of logs, root wads, or large chunks of wood falling into stream channels. Large woody debris is an important habitat component for fish and other aquatic organ-isms (Swanson and others 1976, Harmon and others 1986, Bisson and others 1987, Maser and others 1988, Naiman and others 1992, Samuelsson and others 1994).
- Maintain or aid restoration of the potential of riparian forests to provide shade to the stream channel. Stream shade refers to the

extent to which incoming sunlight is blocked on its way to the stream channel. Stream shade is considered one of the primary factors influencing stream temperature (Brown 1969). Stream temperature influences water chemistry, which can affect the amount of oxygen present to support aquatic life. In addition, all aquatic organisms have a temperature range outside of which they cannot survive.

- Prevent detectable increases in water quantity (peak flow) during storm events. Detectible in this context means a 10 percent or greater increase in peak flow over unmanaged conditions. Peak flows can affect stream channels and in-stream habitat because of the large amount and high velocity of water moving through the stream.

- Protect the integrity of riparian forests from severe endemic windthrow. Windthrow is the breaking or blowing over of trees in the wind. Endemic windthrow results from peak winds that occur fairly frequently (every five years or less), and is considered severe when it causes a significant, temporary loss of riparian function.

Management Strategies and the Working Hypotheses on Which They are Based:

The riparian conservation strategy is based on two primary working hypotheses. The first is that establishing buffers on streams is the best means to meet riparian conservation objectives, and will effectively maintain the stream's key physical and biological functions until the stream recovers sufficiently from past disturbance to allow greater integration of revenue production and habitat conservation. The second is that protecting, maintaining, and restoring habitat complexity afforded by natural disturbance regimes in the western Olympic Peninsula is sufficient to support viable populations of salmonid species and other species dependent on in-stream and riparian environments. These primary working hypotheses are broken down into specific working hypotheses. Table 3-6 on the following page lists the management strategies and the specific working hypotheses on which they are based.

Management strategies are meant to be site specific. The size and configuration of buffers varies across the land base according to the condition of the watershed in which they are located, the presence or absence of potentially unstable slopes or landforms, and severe endemic windthrow risk. This site-specific approach is meant to enable greater integration of revenue production and ecological values in each watershed.

The management strategies use two key terms: interior-core buffer and exterior wind buffer. The interior-core buffer is adjacent to the stream, and the exterior wind buffer is adjacent to the interior-core buffer. Together, the interior-core and exterior buffer comprise the riparian

management zone. Riparian management zones are not harvest deferrals; they are areas managed to meet DNR's measurable objectives and to minimize the effects of upland management activities on riparian areas.

Table 3-6. Riparian Management Strategies and Specific Working Hypotheses

Management Strategy	Specific Working Hypothesis
Apply interior-core buffers that incorporate potentially unstable slopes or landforms that could deliver sediment or debris to the stream network.	***Working Hypothesis 1*:** Within each Type 3 watershed, interior-core buffers should maintain and restore habitat capable of supporting viable listed, non-listed, and candidate populations of salmonid species and other species dependent on in-stream and riparian environments **when buffers are designed to**: 1. maintain or aid restoration of the potential of riparian forests to supply large woody debris to the stream channel, 2. maintain or aid restoration of the level of shade provided to the stream channel, and 3. minimize disturbance of potentially unstable slopes or landforms that could deliver sediment or debris to the stream; **and when interior-core buffers are**: 4) protected from severe endemic windthrow **and that protection is combined with:** 5. prevention of detectable increases in peak flow through the maintenance of hydrologic maturity within the watershed, 6. protection of wetlands, and 7. development and application of comprehensive road maintenance and abandonment plans. ***Working Hypothesis 2:*** The protection of potentially unstable slopes and landforms that may deliver sediment or debris to streams is sufficient to prevent increases in the frequency or severity of slope failure above natural levels along those streams, which also should prevent the severe alteration of the natural input of large woody debris, sediment, and nutrients to the stream network that would have resulted from those failures.

Management Strategy	Specific Working Hypothesis
Establish exterior wind buffers or reconfigure harvested edge or leave tree configuration to prevent severe endemic windthrow in the interior-core buffer.	As implemented, windthrow probability modeling and remote and field assessments adequately identify risks of severe endemic windthrow, and exterior wind buffers or changes to the configuration of the harvested edge, leave tree distribution, or both are sufficient to protect the integrity of the interior-core buffer and the functions and processes it provides.
Implement comprehensive road maintenance and abandonment plans	Implementation of comprehensive road maintenance and abandonment plans is sufficient to restore and maintain fish passages for all fish and their life history stages to available riparian habitat, and to direct road-related sediment away from streams.
Protect wetlands	Protection of wetlands with buffers and special management considerations (DNR 1997, Table IV.9, p. IV.120) is sufficient to prevent net loss of wetland acreage or function.

How are the Objectives Measured?

DNR measures the potential of riparian forests to provide large woody debris and shade to stream channels through a watershed assessment that is automated within the tactical model. In its assessment, the tactical model assesses potential using factors such as forest conditions and distance of trees from the stream channel.

In scheduling harvests, the model's goal is to maintain a "non-declining yield" of large woody debris recruitment and shade potential at a Type 3 watershed scale. A non-declining yield means the potential for large woody debris recruitment and shade remains the same or increases over time. The tactical model also maintains enough hydrologically mature forest in the watershed to avoid a detectible increase (10 percent or greater over unmanaged conditions) in peak flow. A hydrologically mature forest has a canopy that is dense enough to intercept snowfall and often has enough vegetation to absorb water or slow its flow into the stream. More information on the watershed assessment is provided later in this chapter.

DNR analyzes the harvest schedule produced by the tactical model and tallies the total number of acres of regeneration harvest the model

recommended within the default width of the interior-core buffers over a 10-year period. The number of acres is typically small. DNR refers to this total as "allotted acres." Allotted acres and default widths are discussed later in this chapter.

Large woody debris recruitment and shade potential should be restored or maintained if interior-core buffers are applied and allotted acres are not exceeded. DNR tracks allotted acre use on a continual basis and makes that information available in the OESF Living Library to inform timber sales planning.

Peak flow should be prevented if sufficient hydrologically mature forest is maintained in a watershed. As stated previously, the tactical model takes hydrologic maturity into consideration when recommending timber sales. Foresters begin their timber sale planning by considering the tactical model's recommendations as described under "Planning from a Landscape Perspective" in Chapter 2. As needed, foresters also calculate hydrologic maturity when planning timber sales.

DNR uses windthrow probability modeling and remote and field assessments as needed to determine the need for an exterior wind buffer or reconfiguration of the harvested edge, distribution of leave trees, or both to protect the interior-core buffer from severe endemic windthrow. More information on the process DNR follows to designate exterior buffers is provided later in this chapter. If this process is followed, the integrity of the interior-core buffer should be maintained.

DNR has identified uncertainties related to these assumptions. These uncertainties are evaluated and prioritized for research and monitoring projects through the adaptive management process.

How are the Management Strategies Implemented?

Following, DNR discusses specific strategies for interior-core and exterior wind buffers.

►Management Strategy: Apply Interior-Core Buffers

Interior-core buffers are intended to protect and aid restoration of riparian processes and functions and minimize the effects of upland management activities on riparian areas. Interior-core buffers accomplish this by 1) minimizing the disturbance of potentially unstable slopes or landforms to protect and aid natural restoration of riparian processes and functions (DNR 1997, p. IV.109), and 2) maintaining forest cover in

proximity to streams. Erosion and sedimentation from landslides can affect salmonids and other riparian-dependent species by changing channel morphology and reducing habitat complexity (DNR 1997).

When and Where to Apply the Interior-core Buffer

DNR applies interior-core buffers when implementing a variable retention harvest in the adjacent uplands. DNR applies interior-core buffers to the following streams:

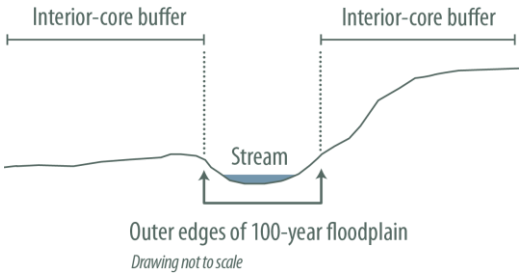
- All Type 1 through 4 streams
- Type 5 streams on potentially unstable slopes or landforms

DNR does not apply an interior-core buffer to Type 5 streams on stable ground.

Width and Configuration of the Interior-core Buffer on Type 1 Through 4 Streams

For all Type 1 through 4 streams, DNR begins with the following default widths of the interior-core buffer. Buffers are measured outward horizontally from the outer edge of the 100-year floodplain (refer to Figure 3-1).

Figure 3-1. Measuring Horizontally



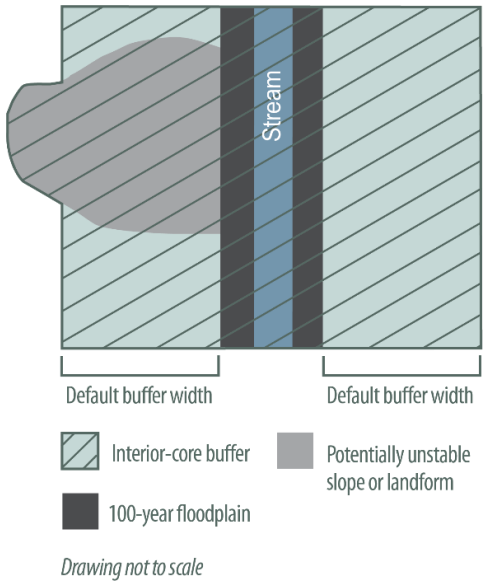
- Type 1 and 2 streams: 150 feet
- Type 3 and 4 streams: 100 feet

Default widths are based on average buffer widths listed in the HCP (Table IV.10. p. IV.123), which are the same for every Type 3 watershed and based on the buffer widths proposed in the literature for several key watershed parameters.

Potentially Unstable Slopes or Landforms

One of DNR's goals for the riparian conservation strategy is to maintain or aid restoration of the sediment regimes in which the riparian system evolved. To accomplish this, DNR prevents an increase in the frequency and severity of landslides by incorporating into the interior-core buffer any potentially unstable slope or landform that could deliver sediment or debris to the stream. These areas are incorporated into the interior-core even when they extend beyond the default width of the buffer (refer to Figure 3-2).

Figure 3-2. Interior-Core Buffer with a Potentially Unstable Slope or Landform

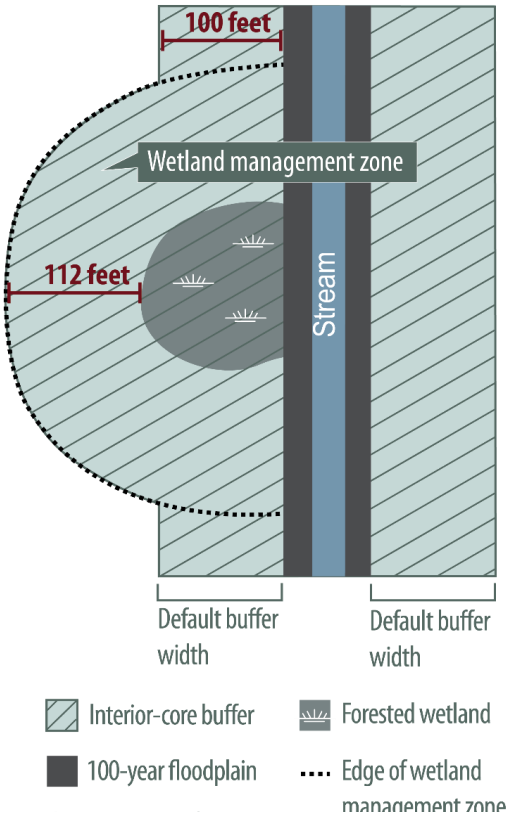


Wetlands

DNR incorporates into the interior-core buffer any wetland and its wetland management zone associated with typed streams. For these areas, DNR compares the OESF wetland and riparian procedures (PR 14-004-500 and PR 14-004-160, respectively) and follows those guidelines that are the most conservative. For example, if the wetland management zone is wider than the width of the interior-core buffer, DNR applies the wetland management zone width around the wetland (refer to Figure 3-3). Similarly, if the wetland is forested and thinning is allowed, DNR follows the riparian thinning guidelines as they are slightly more conservative. DNR does not conduct regeneration harvest in forested wetlands or their riparian management zones.

Figure 3-3. Forested Wetland Incorporated Into Interior-Core Buffer of a Type 3 Stream

In this example, the wetland management zone was slightly wider than the interior-core buffer.



Equipment Limitation Zone

In accordance with WAC 222-30-021, DNR applies a 30-foot-wide equipment limitation zone to all streams (including Type 5 streams) regardless of whether the stream is on stable ground or potentially unstable slopes or landforms. This zone is measured outward horizontally from the outer edge of the 100-year floodplain. Equipment use and disturbances are limited in this area.

Placement of Regeneration Harvest Within Interior-core Buffers

A limited amount of regeneration harvest is allowed inside the interior-core buffer. This amount is determined through a watershed assessment that is automated within the tactical model.

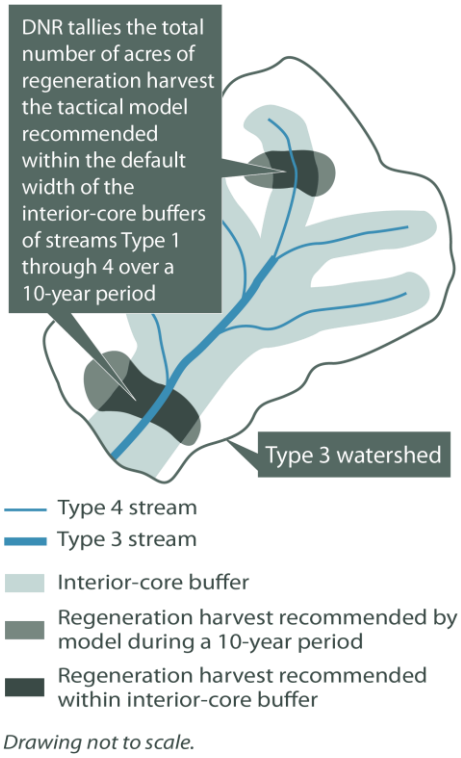
The tactical model assesses the potential of the riparian forest to provide large woody debris and shade to the stream based on factors such as forest conditions and distance of trees from stream. Using this information, the model determines if a regeneration harvest can occur in a riparian area without impeding achievement of the following goals at the Type 3 watershed level:

- Maintain a "non-declining yield" of shade and large woody debris recruitment potential in each Type 3 watershed. A non-declining yield means that proposed timber harvests should either prevent a decrease in shade and large woody debris recruitment potential, or lead to an increase in potential over time.
- Prevent detectable increases in peak flow. Peak flow is prevented by maintaining a sufficient amount of hydrologically mature forest in each watershed.

If a regeneration harvest can occur in a riparian area without impeding achievement of these goals, the model is free to recommend that harvest as part of its optimal solution in the context of all other objectives.

DNR analyzes the model's optimal solution (expressed as a harvest schedule) and tallies the number of acres of regeneration harvest that the model recommended within the default width of the interior-core buffers of Type 1 through 4 streams over a 10-year period in each Type 3 watershed (refer to Figure 3-4). This amount is referred to as the "allotted acres" for a given watershed. DNR updates these amounts when the tactical model is updated and rerun. Depending on model results, some watersheds may not have any allotted acres available.

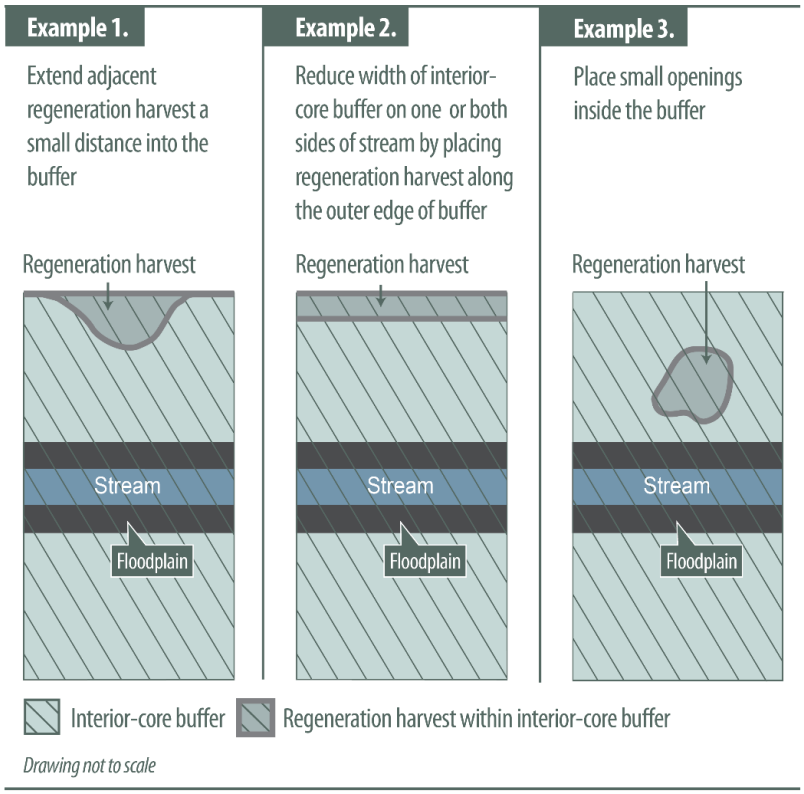
Figure 3-4. Calculating Allotted Acres of Variable Retention Harvest Within the Interior-core Buffer



Drawing not to scale.

Foresters may use allotted acres in a number of ways. For example, they may extend an adjacent regeneration harvest into the interior-core buffer. They may reduce the overall width of the interior-core buffer on one or both sides of the stream by the number of allotted acres. They may use allotted acres for hardwood conversion, in which they replace hardwood trees such as big leaf maple with conifers. Or they may use allotted acres to address unusual circumstances, for example when one side of the interior-core buffer crosses a ridge, and the trees on the far side of the ridge cannot contribute to riparian function. Foresters also may elect not to use the allotted acres, and instead apply the full, default-width of the interior-core buffer. Examples of how allotted acres may be applied are shown in Figure 3-5.

Figure 3-5. Examples of Regeneration Harvest Within Interior-core Buffers



When planning timber sales, foresters should check the OESF Living Library for the most current allotted acres for the Type 3 watershed(s) in which the sale is located, as these numbers are updated on a continual basis. The following guidelines apply to allotted acres:

- Allotted acres are set for the overall Type 3 watershed, not for individual streams. Acres of regeneration harvest may be placed on one stream or split across two or more streams in the watershed, so long as allotted acres are not exceeded for the watershed.
- Allotted acres must be placed at least 25 feet from the outer edge of the 100-year floodplain (measured horizontally).
- Foresters should consider windthrow risk when placing allotted acres within the interior-core buffer. The OESF windthrow probability model, described later in this section, may be used to test harvest configurations.
- In making decisions on allotted acres, foresters should consider not only the current sale but subsequent sales that may occur within the same watershed(s). Once allotted acres are used, additional acres may not become available in that watershed until sufficient

additional riparian forest develops) in the watershed to maintain non-declining yields of large woody debris recruitment and shade.

- Foresters should not place regeneration harvest on any wetland or wetland management zone that has been incorporated into the interior-core buffer, whether that wetland or wetland management zone falls inside or outside the default width of the buffer.

Aside from regeneration harvest as described in this section, other management activities allowed in the interior-core buffer may or may not count against allotted acres. Management activities that DO count against allotted acres include:

- Gaps larger than ¼ acre on a variable density thinning (refer to "Other Activities in the Interior-core Buffer" for more information on thinning).
- Hardwood conversions.
- After a natural disturbance, salvage that involves regeneration harvest. If the number of acres salvaged exceeds allotted acres (or the watershed has no allotted acres available), foresters notify the HCP and Scientific Consultation section before proceeding with the salvage.

Management activities that DO NOT count against allotted acres include:

- Regeneration harvest or gaps on a variable density thinning located on the portion of the potentially unstable slope or landform that extends beyond the default width of the interior-core buffer.
- New roads, existing road right-of-way, yarding corridors, DNR-authorized recreational trail crossings, or new transmission line or gasline projects. Per Section 3 of the Forest Practices Board Manual, roads within 200 feet of typed waters should be avoided where possible. Refer to Section 3 of the manual for more information. To minimize cumulative impacts associated with roads, DNR designs roads to take the most direct route over streams that is operationally feasible.

Other Management Activities in the Interior-core Buffer

- **Pre-commercial and commercial thinning**. Thinning may occur up to the last row of trees adjacent to typed waters except on any 100-year floodplain that has been designated by the Federal Emergency Management Agency (FEMA) on flood insurance rate maps (refer to DNR's corporate GIS layers). These floodplains are typically associated with Type 1 and 2 streams (DNR 1997 p. IV.110). To maintain shade, DNR does not thin any area of the interior-core

buffer below an average of RD 35. DNR follows the forest practices rules and Chapter 16 of the Forest Practices Board Manual when delineating and conducting activities on potentially unstable slopes.

- **Restoration efforts**, including habitat-enhancement projects such as the creation of snags, down wood and in-stream large woody debris.
- **Application of herbicides** in accordance with WAC 222-38-020, *Handling, Storage, and Application of Pesticides* and PR 14-006-040, Site Preparation and Vegetation Management.
- **Brush and bough harvest**.
- **Pruning**.
- **Peer-reviewed and DNR approved research and monitoring projects** designed to improve the integration of revenue and ecological values.
- **Operational trials**. Refer to "Research and Monitoring" later in this chapter for more information.

Applying Interior-core Buffers to Type 5 Streams

DNR applies an interior-core buffer on all Type 5 streams located on field-verified, potentially unstable slopes or landforms. The interior-core buffer includes the stream and the identified potentially unstable slope or landform. Thinning and regeneration harvest is allowed in the interior-core buffer of Type 5 streams; for harvest in these areas, DNR will follow the forest practices rules and Chapter 16 of the Forest Practices Board Manual. There is no acreage limit for regeneration harvest on the interior-core buffer on Type 5 streams.

►Management Strategy: Establish Exterior Wind Buffers

Exterior wind buffers are designed to protect the integrity of the interior-core buffer from the loss of riparian function that results from severe endemic windthrow. It is neither expected nor intended that the exterior wind buffer will prevent all windthrow from occurring in the interior-core buffer. Windthrow in streamside forests is a normal occurrence that serves as an important mechanism for the recruitment of large woody debris to the stream channel and also contributes to the natural sediment budget of the stream. However, DNR relies on interior-core buffers to maintain a range of ecosystem functions (including habitat for northern spotted owls and other species) that may be compromised if severe endemic windthrow occurs.

The exterior wind buffer is not designed to protect the interior-core from *catastrophic* windthrow, which results from strong peak winds that occur infrequently (more than 20 years between occurrences). Such winds can damage timber across a large area, including both interior forest stands and forest stands with exposed edges.

When to Apply the Exterior Wind Buffer

A number of factors promote susceptibility to windthrow on the western Olympic Peninsula. Mitchell and Lanquaye-Opoku (2007) found that the proportion of harvested edge segments affected by windthrow increased with exposure of the edge to peak winds: windthrow was most prevalent where the harvest edge directly faced the prevailing winds *and* the edge was exposed in multiple directions to winds with a fetch of at least 100 meters (fetch is the length of the forest opening over which a given wind has blown). Other factors include the local wind climate (distance from coast, mean annual wind speed, elevation, and aspect) and stand height. Edge orientation, wind exposure, and topographic attributes were found to be more important than stand or soil variables in predicting windthrow.

The need for an exterior wind buffer is based on an assessment of the likelihood of severe endemic windthrow in the interior-core buffer. To determine the need for an exterior wind buffer, for each timber sale foresters run the OESF windthrow probability model, or a future model as developed, using the "severe endemic windthrow" setting. In DNR's current model, this setting identifies segments of the interior-core buffer with a 5 percent or greater chance of severe endemic windthrow, which is defined in the model as 90 percent of the area experiencing 50 percent or greater canopy loss. Foresters run the model at both the watershed and stream-reach scale.

DNR may combine the use of the model with qualitative methods to identify windthrow risk. Those methods include but are not limited to review of aerial photos and other information (to understand windthrow trends in the area) or completion of the "Buffer Strip Survival Rate Worksheet" in "Designing Stable Buffer Strips for Stream Protection" in the Forestry Handbook. If the windthrow probability model is not available, DNR uses these qualitative techniques to identify windthrow risk.

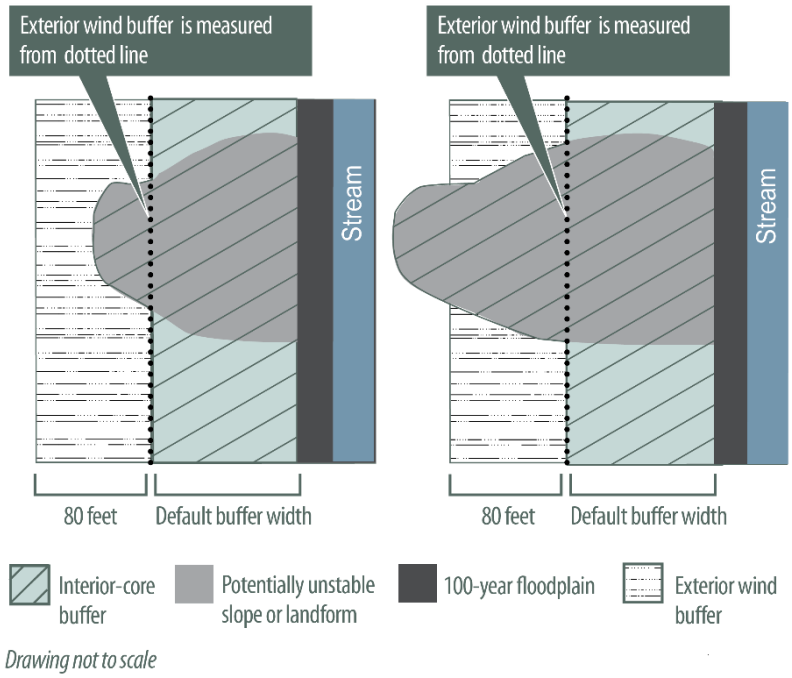
If there is a risk of severe endemic windthrow, DNR may either place an exterior wind buffer on segments of the interior-core buffer identified as having a risk of severe endemic windthrow , or modify the shape and orientation of the harvested edge, distribution of leave trees, or both to reduce the risk of severe endemic windthrow. If the latter, foresters rerun the OESF windthrow probability model on the reconfigured timber sale.

If there is still a risk of severe endemic windthrow, foresters apply an exterior wind buffer where needed.

Configuration of the Exterior Wind Buffer

Where applied, the exterior wind buffer measures 80 feet (horizontal distance) outward from the outer edge of the default width of the interior-core buffer (refer to Figure 3-6). The dimensions of the exterior wind buffer represent DNR's best understanding of what might be required to protect the integrity of the interior-core and the riparian functions the interior-core buffer provides. The width of the exterior wind buffer is based on empirical studies of windthrow patterns on Vancouver Island, British Columbia (Lanquaye 2003) that concluded that less than 25 percent of the windthrow extended further than 25 meters (82 feet) into the edge, and less than 10 percent of the windthrow extended beyond 50 meters (164 feet) into the edge.

Figure 3-6. Measuring the Exterior Wind Buffer



Management Activities in the Exterior Wind Buffer

- **Pre-commercial and commercial thinning**. Thinning is allowed in all areas of the exterior wind buffer. Thinning should produce and maintain forest stands that are wind-firm, robust, and compositionally diverse. The spacing of tree removal at the time of thinning is determined in the field based on an assessment of the physical and biological condition of the site. The OESF windthrow

probability model can be used to test different thinning configurations to ensure wind firmness after thinning.

- **Application of herbicides** in accordance with WAC 222-38-020, *Handling, Storage, and Application of Pesticides* and PR 14-006-040, *Site Preparation and Vegetation Management*.
- **Brush and bough harvest**.
- **Pruning**.
- **New roads, existing road right-of-way, yarding corridors, or DNR-authorized recreational trail crossings**.
- **Peer-reviewed and DNR approved research and monitoring projects** designed to improve the integration of revenue and ecological values.
- **Operational trials**. Refer to "Research and Monitoring" later in this chapter for more information.

►Management Strategy: Implement Comprehensive Road Maintenance and Abandonment Plans

A well designed, located, constructed, and maintained system of forest roads is essential to forest management and protection of public resources. DNR's overall objectives for road construction and maintenance in the OESF include the following (DNR 1997, p. IV.118):

- Annually, assess conditions of active roads.
- Maintain existing roads to minimize drainage problems and sediment delivery to streams.
- Minimize active road density. Stabilize and close access to roads that no longer serve a management function or that cause burdensome management or environmental problems. Build new roads only when a weighing of ecological, operational, and economic factors shows a new road to be the most reasonable option.
- Build new roads based on sound engineering and consistent with the forest practices rules.
- Prioritize roads for decommissioning, upgrading, and maintenance during annual road maintenance and abandonment planning.
- Identify fish passage blockages that may develop over time at stream crossings and schedule blockage removal.

WAC 222-24-051 requires large forest landowners,[3] including DNR, to prepare and submit road maintenance and abandonment plans (RMAPs). These plans include forest road inventories and schedules for any repair work that is needed to bring roads up to current state standards. DNR has prepared RMAPs for each of the 11 landscapes in the OESF.

Comprehensive RMAPs specify the road work that is needed and when the work will be completed. Some of the work (for example, culvert and cross-drain projects) is done independently from timber sales and other work is done in conjunction with specific sales (for example, road maintenance prior, during and after timber sales and other forest management activities). DNR conducts road maintenance and abandonment planning and projects in accordance with WAC 222-24 *Road Construction and Maintenance* and the Forest Practices Board Manual.

Suspend Timber Hauling During Storm Events

DNR also considers how operations can be adjusted to further minimize delivery of fine sediment to streams. For example, DNR may suspend timber hauling on state trust lands in the OESF during storm events, when heavy rainfall can potentially increase surface water runoff and sediment delivery, unless the road is designed to handle wet-weather haul. The decision to suspend timber hauling on state trust lands is based on professional judgment. A weather event is considered a storm event when high levels of precipitation are forecast and there is a potential for drainage structures, such as culverts and ditches, to be overwhelmed, increasing the potential for sediment delivery to streams. Whether timber hauling is suspended or not, DNR compliance foresters monitor haul roads to determine if potential problems are developing that may lead to sediment delivery to streams and take action as necessary.

►Management Strategy: Protect Wetlands

DNR's wetland strategy on state trust lands in the OESF is intended to protect wetland plant and wildlife species, water quality, soils, and plant communities. Statewide, DNR allows no net loss of wetland acreage or function (DNR 2006). Wetland protection aims to 1) retain the plant canopies and root systems that maintain water transpiration and uptake processes, 2) minimize disturbance to natural surface and subsurface flow regimes, and 3) ensure stand regeneration (DNR 1997, p. IV.119).

Wetlands serve many vital landscape functions, including protection and improvement of water quality, storm-water retention, peak flow attenuation, seasonal stream flow augmentation, nutrient supply to downstream ecosystems, and habitat for many native wildlife species, either seasonally or for part of their lifecycles.

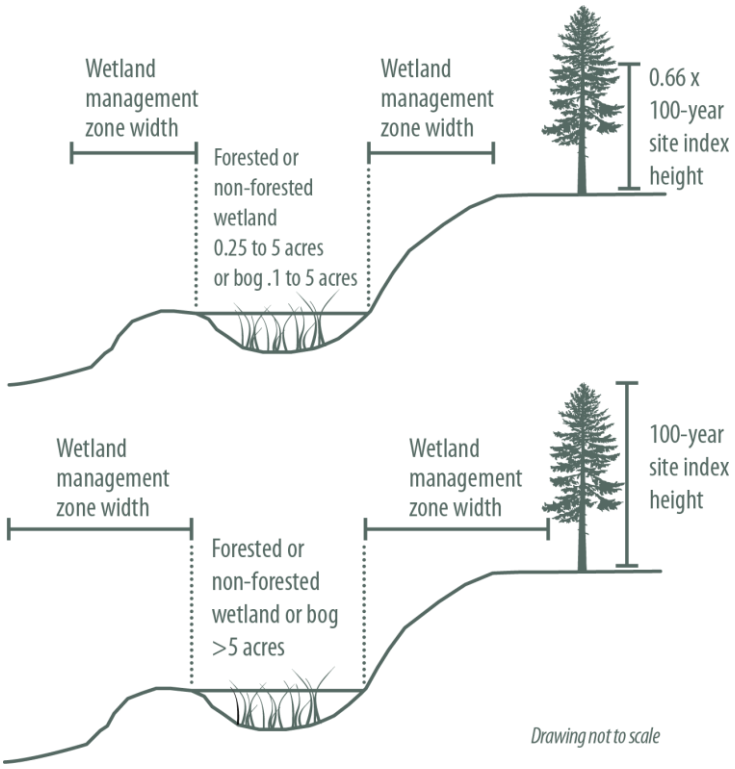
Wetlands that Require Protection

In the OESF, forested and non-forested wetlands (including bogs), as defined by WAC 222-16, are protected with wetland management zones and other management considerations if they are .25 acre or larger (wetlands) or .1 acre or larger (bogs) (DNR 1997, p. IV.120). A series of wetlands smaller than .25 acre will be protected if they function collectively as a larger wetland (DNR 1997, P. IV. 120). A wetland or bog is considered forested if current canopy closure (if the trees are mature) or probable future canopy closure (if the trees are not mature) is 30 percent or higher.

Width of the Wetland Management Zone

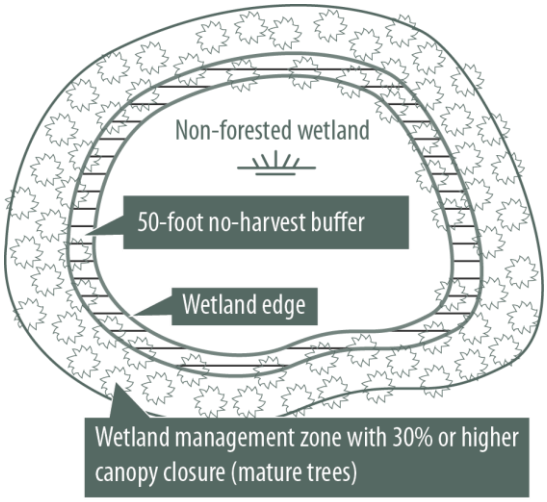
The width of the wetland management zone depends on the size and type of the wetland in question. The width of the wetland management zone is based on the 100-year site potential conifer tree height of the adjacent riparian forest. Foresters use the site index for site adapted (vigorously growing) species and measure the wetland management zone outward horizontally from the outer edge of the wetland (Figure 3-7). Widths of wetland management zones are listed in Tables 3-7 and 3-8 on p. 40 and 3-41, respectively.

Figure 3-7. Measuring the Wetland Management Zone



No-Harvest Buffer

Figure 3-8. No-harvest Buffer



Within the wetland management zone, DNR designates a 50-foot no harvest buffer around non-forested wetlands that have forested wetland management zones (refer to Figure 3-8). A wetland management zone is considered forested if current canopy closure (if the trees are mature) or probable future canopy closure (if the trees are not mature) is 30 percent or higher. The no-harvest buffer is measured outward horizontally from the outer edge of the non-forested wetland. No regeneration or thinning will occur within the no-harvest area.

Table 3-7. Wetland Management in the OESF (DNR 1997, p. IV.120)

Wetland type	Wetland size	Width of wetland management zone	No-harvest buffer	Thinning in wetland?	Thinning in wetland management zone?
Forested wetland	0.25 - 5 acre	2/3 100-year site potential tree height	None	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre
Forested wetland	> 5 acre	100-year site potential tree height	None	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre
Non-forested wetland	0.25 - 5 acre	2/3 100-year site potential tree height	50 feet	Not applicable	Allowed outside no-harvest buffer. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre
Non-forested wetland	> 5 acre	100-year site potential tree height	50 feet	Not applicable	Allowed outside no-harvest buffer. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre

Table 3-8. Bog Management in the OESF (DNR 1997, p. IV.120)

Wetland type	Wetland size	Width of wetland management zone	No-harvest buffer	Thinning in bog?	Thinning in wetland management zone?
Forested bog	0.1 - 5 acre	2/3 100-year site potential tree height	None	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre
Forested bog	> 5 acre	100-year site potential tree height	None	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre
Non-forested bog	0.1 - 5 acre	2/3 100-year site potential tree height	50 feet	Not applicable	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre
Non-forested bog	> 5 acre	100-year site potential tree height	50 feet	Not applicable	Allowed. Perpetuate wind firmness and ≥ 120 ft^2 basal area per acre

Management Activities Within Wetlands and Wetland Management Zones

At a minimum, harvest in wetlands and their wetland management zones will be consistent with the level of protection outlined in this section and summarized in Tables 3-7 and 3-8. Forestry operations in forested wetlands and wetland management zones (outside of no-harvest buffers) will minimize entries into these areas and utilize practices that minimize disturbance, such as directional felling of timber away from wetlands and use of equipment that causes minimal soil disturbance. If ground

disturbance caused by forest management activities alters the natural surface or subsurface drainage of a wetland, then restoration of the natural drainage will occur.

Thinning

Forested wetlands and their wetland management zones may be thinned. For all wetlands and wetland management zones, particularly those in areas susceptible to windthrow, a primary conservation objective is the maintenance of wind-firm stands. In forested wetlands and their wetland management zones (outside of the 50-foot no-harvest buffer on non-forested wetlands), DNR perpetuates a basal area of at least 120 square feet per acre. Similar to exterior wind buffers, the spacing of tree removal at the time of thinning is determined in the field by the forester based on an assessment of the physical and biological condition of the site. The OESF windthrow probability model can be used to test different thinning configurations to ensure wind firmness after thinning. Foresters also may reference recent windthrow in other, similar wetlands or wetland management zones. DNR retains green trees that are representative of the dominant and co-dominant tree species prior to thinning.

Forested wetland management zones around non-forested wetlands can be thinned (outside of the no-harvest buffer), but DNR will maintain wind firm stands as described in the preceding paragraph.

Roads and Landings

In order to assure that there is no net loss of wetland function, all road and landing construction near or within wetlands are conducted in accordance with WAC 222-24 *Road Construction and Maintenance* and the guidance for wetlands provided in the HCP (p. IV.69 and IV.119). Roads are not constructed in bogs or low nutrient fens (a type of wetland that usually has sedge peat soils and is in contact with nutrient-rich ground and surface water). Field staff, in consultation with DNR's HCP and Scientific Consultation Section, provide on-site and in-kind mitigation of acreage and function for wetland losses from road or landing construction, or other management activities within wetlands or wetland management zones that result in a loss of wetland function. The effects of roads on natural surface and subsurface drainage will be minimized. Roads are designed to take the most direct route operationally feasible across wetlands and wetland management zones to minimize the cumulative impacts associated with roads.

Other Management Activities

- **Herbicides.** The use and application of herbicides within wetlands and wetland management zones is done in accordance with WAC

222-38-020, *Handling, Storage, and Application of Pesticides* and PR 14-006-040, *Site Preparation and Vegetation Management*.

- **Restoration efforts and pruning.**
- **DNR-authorized Recreational trail crossings.** DNR-authorized recreational trail crossings are allowed through wetland management zones but are avoided in both forested and non-forested wetlands. Trail crossings are designed to take the most direct route operationally feasible across wetland management zones.

Research and Monitoring

Harvest experiments to achieve wind-firm stands may be considered in wetlands susceptible to windthrow (DNR 1997, p. IV.120). Projects of this nature would be conducted through the research and monitoring program.

Marbled Murrelet Conservation Strategy

At the time the HCP was adopted, DNR did not have enough information to develop a long-term conservation strategy for marbled murrelets. In absence of a long-term strategy, DNR follows the interim HCP marbled murrelet conservation strategy (DNR 1997, p. IV.39 through IV.42) using the guidance provided in the "Memorandum for Marbled Murrelet Management within the Olympic Experimental State Forest" dated March 7, 2013 (OESF Marbled Murrelet Memo). The purpose of the OESF Marbled Murrelet Memo is to protect marbled murrelet habitat and allow timber harvest and other activities to proceed while the long-term strategy is being developed. Once the long-term strategy is completed and approved, this forest land plan will be updated if and as necessary.

Goal:

Provide forest conditions in strategic locations on forested trust lands that minimize and mitigate incidental take of marbled murrelets resulting from DNR's forest management activities.

Measurable Objective:

Protect areas currently identified in the OESF Marbled Murrelet Memo until a long-term conservation strategy for marbled murrelet habitat has been developed.

Management Strategies:

Following are DNR's strategies for implementing the interim marbled murrelet conservation strategy. Working hypotheses will be developed as the long-term conservation strategy is completed and approved.

- Implement existing HCP obligations through guidance provided in the OESF Marbled Murrelet Memo.
- Implement the marbled murrelet long-term conservation strategy when it is completed and approved.

How is the Objective Measured?

The objective is met so long as the areas listed in the OESF Marbled Murrelet Memo (or the areas listed in the marbled murrelet long-term conservation strategy when completed and approved) are protected.

How are the Management Strategies Implemented?

Refer to the OESF Marbled Murrelet Memo, or the marbled murrelet long-term conservation strategy when completed and approved, for implementation information such as guidelines for deferrals, buffers, timing restrictions, and roads.

Marbled Murrelet
Photo courtesy Rich MacIntosh

Multispecies Conservation Strategy

The multispecies conservation strategy covers habitat for unlisted wildlife species in the OESF, but also includes provisions for other species that face some risk of at least local extinction. The latter category includes federally listed species such as northern spotted owls and marbled murrelets; federal species of concern such as northern goshawks and harlequin ducks; state sensitive species such as the Olympic mudminnow; and state candidate species such as pileated woodpeckers.

Under the multispecies conservation strategy for the OESF, habitat for unlisted species and species at risk of local extinction is largely an outcome of landscape-level management in the OESF (DNR 1997, p. IV.137). For example, conservation measures for riparian areas and northern spotted owl and marbled murrelet habitat are expected to create interconnected patches of late-successional, mid-aged, and young forests (DNR 1997, p. IV.137) that would support a range of species. This strategy also includes site-or species-specific conservation measures such as protection of balds, caves, and other unique habitats and nesting sites for specific species.

The following goals, measurable objective, and strategies are based on p. IV.134 through 143 of the HCP.

Goals:

- Develop and implement a forest land plan that does not appreciably reduce the likelihood of survival and recovery of unlisted species on the Olympic Peninsula.
- Learn to integrate the values of older forest ecosystems and their functions with revenue production.
- Fill critical information gaps related to the composition, structure, and function of aquatic, riparian, and upland ecosystems, and the links between these and forest management activities and conservation of habitat for unlisted species.

Measurable Objective:

Provide a variety of habitat conditions to support multispecies goals by meeting measurable objectives for the northern spotted owl, marbled murrelet, and riparian conservation strategies and revenue production, and by implementing site- or species-specific conservation measures.

Management Strategies and the Working Hypotheses on Which They are Based:

Refer to Table 3-9.

Table 3-9. Multispecies Strategies and the Working Hypothesis on Which They are Based

Management Strategy	Working Hypothesis
Implement the northern spotted owl, riparian, and marbled murrelet conservation strategies.	DNR can meet its objectives for conservation of habitat for unlisted species and species at risk of local extinction in the OESF by managing stands and landscapes to meet its conservation objectives for the riparian, northern spotted owl, and marbled murrelet conservation strategies, and by implementing additional site- or species-specific conservation measures.
Follow existing procedures and guidelines for unique habitats.	
Manage habitat for unlisted species of concern.	

How is the Objective Measured?

Refer to respective sections of this plan for how objectives are measured for revenue production and for northern spotted owl, riparian, and marbled murrelet conservation strategies.

How are the Management Strategies Implemented?

►Management Strategy: Implement the Northern Spotted Owl, Riparian, and Marbled Murrelet Conservation Strategies

For detailed information on these strategies, refer to their respective sections in this chapter.

►Management Strategy: Follow Existing Procedures and Guidelines for Unique Habitats

Some wildlife species require special landscape features or habitat elements that may not be adequately conserved by species-specific strategies. Special conservation measures for talus field, caves, cliffs, large snags, and large, structurally unique trees may be important to these species (DNR 1997, p. IV.137). The protection of uncommon habitats and habitat elements is described in the HCP, and on-the-ground guidance is given in DNR's Forestry Handbook. For all harvest activities, DNR follows these procedures and guidelines:

- PR 14-004-046, *Identifying and Managing Structurally Complex Forests to Meet Older Forest Targets (Westside)*
- PR 14-004-170, *Protecting Talus Fields*
- PR 14-004-500, *Wetland Management in the OESF HCP Planning Unit*
- PR 14-006-090, *Management of Forest Stand Cohorts*
- GL 14-004-010, *Old-growth Timber Harvest Deferral and Protection (Westside)*
- PR 14-004-230, *Protecting Mineral Springs*
- PR 14-004-190, *Protecting Cliffs*
- PR 14-004-180, *Protecting Caves*
- PR 14-004-2200, *Protecting Balds*

►Management Strategy: Manage Habitat for Unlisted Species of Concern

For certain species, conservation measures are in place for known nesting, denning, and/or roosting sites as well as for habitat that is not widely distributed. DNR is not required to survey for nests, dens, roosts, or individual occurrences of unlisted species (DNR 1997, p. IV. 136). However, for all harvest activities, DNR follows these procedures:

- PR 14-004-290, *Protecting Pileated Woodpecker Nests*
- PR 14-004-300, *Protecting Vaux's Swifts Nests and Night Roosts*
- PR 14-004-340, *Protecting Peregrine Falcon Habitat*
- PR 140-004-280, *Protecting Pacific Fisher Dens*
- PR 14-004-260, *Protecting Northern Goshawk Nest West of the Cascades*
- PR 14-004-310, *Protecting Myotis Bat Communal Roosts and Maternal Colonies*
- PR 14-004-250, *Protecting Harlequin Duck Nests*
- PR 14-004-240, *Protecting Common Loon Nests*

- PR 14-004-330, *Protecting Bald Eagle Nesting , Roosting, and Foraging Sites*
- PR 14-004-390, *Protecting Aleutian Canada Goose Habitat*
- Policy 14-009, *Wildlife Habitat*

Pileated Woodpecker
Photo courtesy USFWS

Harlequin Duck
Photo courtesy USFWS

Adaptive Management

The idea of management actions that continue to change in response to new information is fundamental to the concept of ecologically-based sustainable forest management (Lindenmayer and Franklin 2002).

The HCP requires DNR to "demonstrate a process by which land management activities in the Experimental Forest can respond to new information" (DNR 1997, p. I.15). The adaptive management process is described in detail in Chapter 4 and also in PR-14-004-530, *Adaptive Management in the OESF HCP Planning Unit*. Following are DNR's goal, measurable objectives, and strategies, which are based on p. IV.82 through IV.85 and p. V1 through V10 of the HCP and Implementation Agreement, respectively.

Goal:

Continually improve the integration of revenue production and ecological values by learning from the outcomes of operational and experimental approaches.

Measurable Objective:

Implement a formal adaptive management process in which incomplete knowledge (uncertainties) related to forest management is identified, hypotheses around desired outcomes are formulated, actions to test these hypotheses are implemented, and reliable information is provided for decision makers to use to consider management adjustments.

Management Strategies:

- Implement the adaptive management process as described in PR-14-004-530 and Chapter 4.
- Conduct effective information management, which includes documenting recommended and approved research and monitoring activities and management changes.

- Share the outcomes of the adaptive management process with the Federal Services, stakeholders, other land managers, and the general public.

How is the Objective Measured?

DNR reports the outcomes of the adaptive management process described in the adaptive management procedure (PR 14-004-530) in the HCP Annual Report to the Federal Services.

How are the Management Strategies Implemented?

Refer to Chapter 4 and PR 14-004-530 for a full discussion of the adaptive management process.

Research and Monitoring

Research and monitoring are commitments in the HCP and the OESF is identified as the priority location for implementing them. Also, research and monitoring are the primary sources of information for a science-informed adaptive management process. Following are DNR's goal, measurable objectives, and strategies for research and monitoring, which are based on p. IV.82 through IV.85 and p. V.1 through V.10 of the HCP and Implementation Agreement, respectively.

Goal:

Explore the links between management activities and ecological processes and functions at both the stand and landscape level (DNR 1997, p. I.14).

Measurable Objectives:

- Conduct implementation monitoring to determine whether the HCP conservation strategies are implemented as written (DNR 1997, p.V.1).
- Conduct effectiveness monitoring to determine whether implementation of the conservation strategies results in anticipated habitat conditions (DNR 1997, p.V.1).
- Conduct validation monitoring to evaluate cause-and-effect relationships between habitat conditions resulting from implementation of conservation strategies, and the salmonid and northern spotted owl populations these strategies are intended to benefit (DNR 1997, p.V.1).
- Conduct research to obtain information to move from short- to long-term conservation strategies; assess and improve effectiveness of the four major habitat conservation strategies (northern spotted owl,

riparian, marbled murrelet, multispecies); and increase management options and commodity production opportunities (DNR 1997, p. V.6)

- Conduct operational trials to explore new ideas for forest management techniques, equipment, or contract stewardship.

Management Strategies:

- Document the types, amounts, and locations of forest management activities and assess their compliance with requirements of the HCP habitat conservation strategies (implementation monitoring) (DNR 1997, p. V.2).
- Document changes in riparian, northern spotted owl, and marbled murrelet habitat conditions and determine whether implementation of the HCP habitat conservation strategies results in anticipated habitat conditions (effectiveness monitoring) (DNR 1997, p. V.2).
- Document habitat use by salmonids, northern spotted owls, and marbled murrelets and evaluate species responses to management activities (validation monitoring) (DNR 1997, p. V.2).
- Develop study plans and implement research projects that are scientifically credible and cost-effective (DNR 1997, p. V.8).
- Implement small scale, short time-frame operational trials to test or prototype innovative ideas and techniques for forest operations.
- Conduct effective information management, which includes documenting research and monitoring activities; making records easily accessible; and exchanging information such as project reports, research and monitoring data, and peer-reviewed publications within DNR and with external partners.
- Collaborate with research organizations, local land managers, and other interested parties to gain expertise, improve efficiency, communicate knowledge, and share the cost of research and monitoring projects.

How are the Objectives Measured?

The benchmark for achieving research and monitoring objectives is the development and adoption of peer-reviewed study plans, and tracking their accomplishment through progress reports. Study plans are linked to specific uncertainties identified through the adaptive management process, and include testable hypotheses, detailed study design, field protocols, and analytical methods. Similar to the adaptive management

procedure, study plans help institutionalize monitoring and sustain DNR's attention on monitoring over time.

The benchmark for achieving operational trials is the documentation and sharing of results across DNR.

How are the Management Strategies Implemented?

Refer to Chapter 4 for a full discussion of the research and monitoring and operational trials programs.

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[1] DNR's interpretation of "restoration" is based on p. IV.91 of the HCP.

[2] The HCP anticipated that it would take between 40 to 60 years to reach the 40 percent Young Forest Habitat and better threshold in OESF landscapes. However, those estimates were based on stand age alone; in other words, when a stand reached a certain age it was assumed to be habitat. Using stand age alone can result in an over-estimate of habitat. DNR's current projections are based on an analysis of forest stand structure, not age. This change in methodology accounts for differences between HCP and current estimates of the length of time needed to attain the 40 percent threshold.

[3] Large forest landowners harvest an annual average of more than two million board feet of timber from their own forest land in Washington State.

4

Research, Monitoring, and Adaptive Management

In this chapter, DNR describes the adaptive management process and research and monitoring program, including near-term priority projects.

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Research, Monitoring, and Adaptive Management

In the OESF, DNR intentionally learns and adapts management to new information to continuously improve the integration of revenue production and ecological values.

Adaptive Management

The concept of adaptive management of natural resources was introduced in the 1970s and 1980s (Holling 1978; Walters 1986) as a way to manage natural resources when knowledge of ecosystem functions or the effects of human actions is incomplete. Incomplete knowledge (uncertainty) is an inherent and pervasive feature of managing natural resources.

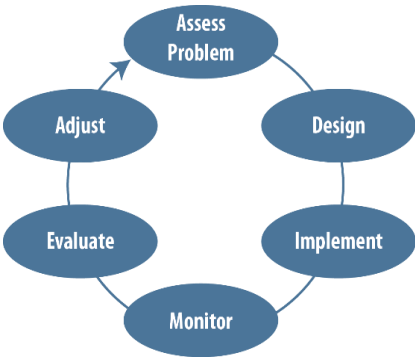
Adaptive management has been defined in the literature in many different ways. DNR has selected the definition by Bunnel and Dunsworth (2009) because of its emphasis on different sources of learning:

> Adaptive management is a formal process for continually improving management practices by learning from the outcomes of operational and experimental approaches.

As DNR interprets this definition, adaptive management is a structured (formal), science-informed process in which key uncertainties are identified; hypotheses around a system's functioning, desired outcomes, and management effects are formulated; actions to test hypotheses are implemented; and the knowledge gained is used to affirm or adjust

management. This process is often depicted as a cycle (Figure 4-1). A modified version of this cycle will be used later in this chapter.

Figure 4-1. The Adaptive Management Process
Williams and others 2007



DNR interprets "continually improving management practices" as learning to better integrate revenue production and ecological values. This learning is intentional. Actions are taken not only to manage but also to learn about the managed systems; in other words, to obtain information that increases confidence in ongoing management or provides alternative management solutions.

Uncertainty and other key terms used in this chapter are defined in Chapter 5 (glossary).

Why Adaptive Management?

Land managers such as DNR often must find a way to continue managing natural systems to reach their land management objectives in the face of uncertainty. Adaptive management is one approach to managing in the face of uncertainty. Other approaches include precautionary and trial and error.

- **Precautionary approach:** When scientific information that an action or policy may be harmful is incomplete, managers err on the side of caution. This approach derives from the precautionary principle[1] in that an activity does not take place until it is proven safe. This approach differs from the strict interpretation of the precautionary principle by acknowledging that not all human actions are irreversibly harmful unless proven otherwise and that economic and social factors should be considered when taking precautions. In the OESF, the precautionary approach is most often implemented by limiting activities in specific areas, such as potentially unstable slopes and high quality habitat, until more information is collected to elucidate key processes and relationships. These limitations or restrictions are designed to alleviate potential ecological harm. At the same time, they also reduce revenue, provide little opportunity for

learning, and in some cases, limit active restoration and habitat enhancement activities.

- **Trial-and-error approach:** Initial management decisions and subsequent implementation are based on the best available science and professional judgment and may include forecasting techniques such as formal risk assessment and scenario planning. Under this approach, managers gain some knowledge through the experience of implementing management strategies. However, such learning is not acquired in an intentional, structured process. For example, key uncertainties are not explicitly stated, reduction of the uncertainties is not a management objective, and a plan for acquiring reliable information through research and monitoring is not developed beforehand. The effects of the implemented strategy may or may not be monitored, and subsequent management decisions are made based on the reactions to a perceived failure of the strategy (Walters and Holling 1990). The most common forces for major changes under this approach are external drivers such as regulations, political pressure, and market conditions. Currently, this is the dominant paradigm in natural resource management worldwide (Willhere 2002).

Multiple considerations—regulatory, social, economic, and ecological—play a role in the selection of adaptive management over the other two approaches (refer to discussions in Lee 1999 and Failing and others 2004). Five considerations are central to determining whether adaptive management is prudent (Williams and Brown 2012):

- In spite of uncertainty about the outcomes, active management is required for an organization to meet its objectives.
- Clear and measurable management objectives guide decision making. These objectives and associated metrics are used to evaluate whether actions have the desired effect.
- Research and monitoring can be designed and conducted to reduce uncertainties. In other words, it is possible to implement information-gathering activities that are economically feasible and that are reasonably expected to produce relevant information in an acceptable timeframe.
- Decision makers have the ability and interest to act on new information to make changes to management. Opportunities exist to apply learning to management.
- Decision makers and stakeholders are actively involved and make a sustained commitment of time and resources.

DNR believes that **the OESF meets all five of these considerations** and has three additional reasons to select adaptive management:

- The idea of management actions that continue to change in response to new information and insights is fundamental to the concept of sustainable forest management (Lindemayer and Franklin 2002, DNR 2006).

- The adaptive management approach conforms to the original OESF vision for "applying non-traditional silvicultural practices, testing new concepts, measuring outputs, and revising forest practices to optimize both commodity production and ecological values" (Commission on Old Growth Alternatives for Washington's Forest Trust Lands 1989, p. 24).

- Adaptive management is a commitment in the HCP. The HCP identifies adaptive management (referred to as the "systematic application of knowledge gained") as one of the six management processes recommended for the OESF. The HCP also described "a process of integrating intentional learning with management decision making and course adjustments" as an important component of the experimental approach to management (DNR 1997, p. I.15). Finally, the HCP Implementation Agreement listed specific adaptive management practices to be implemented by DNR (DNR 1997, p. B.10 through B.11). In addition, the Federal Services consider adaptive management as a tool to address uncertainty in the conservation of species covered by habitat conservation plans (refer to *Habitat Conservation Planning Handbook* [USFWS and National Marine Fisheries Service {NMFS} 1996 and its addendum [USFWS and NMFS 2000]).

Text Box 4-2 lists some of the key characteristics of adaptive management.

Text Box 4-2. Key Characteristics of Adaptive Management

- Learning is triggered by the explicit acknowledgement of risk and uncertainties about the response of a particular system to management actions. Reducing these uncertainties (in other words, learning) is a focus of adaptive management.
- It is an intentional learning process based on the scientific method, as opposed to an ad-hoc reaction to a management problem.
- Interpreting research, monitoring, and operational findings and making recommendations to managers are critical steps in the process.
- A structured decision-making process, defined in advance, is used to close the loop between gathered information and management decisions.
- The implications of management adjustments that may result from the new information are clearly understood.
- Multiple iterative steps are used to ensure that improvement is continuous.

Goal and Scope of Adaptive Management

The goal of adaptive management in the OESF, as stated in Chapter 2, is to continually improve the integration of revenue production and ecological values by learning from the outcomes of operational and experimental approaches. The scope is described as follows:

- The **ultimate focus of adaptive decision-making is on management**, and learning is valued in terms of its contribution to improving management (Walters, 1986). Adaptive management, and the research and monitoring that occurs as part of this process, is focused on uncertainties related to the goals, objectives, and management strategies for revenue production and the four major HCP conservation strategies (northern spotted owl, riparian, marbled murrelet, and multispecies) presented in Chapter 3. The knowledge gained through the adaptive management process is expected to increase DNR's confidence in ongoing management practices or to

prompt DNR to change its management of natural resources in the OESF.

- Adaptive management is a **science-informed process.** However, DNR acknowledges that scientific findings may not be the sole driver for decisions within the adaptive management process; political, social, and economic realities also are expected to affect decision making. For example, when making decisions, DNR must consider its fiduciary responsibilities as a trust lands manager, as well as its responsibilities per the HCP, the *Policy for Sustainable Forests*, and other policies. An adaptive management process that does not respect these realities is likely to be overly idealized and probably unrealistic. Some management adjustments in the OESF may be prompted by factors other than scientific findings. Examples include natural disturbances such as catastrophic winds or fire and economic factors such as changes in timber markets. If management adjustments are prompted solely by these factors, the changes are not considered part of the science-informed adaptive management process described in this chapter.

- Because of DNR's legal obligations under the HCP, most research and monitoring projects completed through the adaptive management process focus on **ecological lines of investigation,** particularly as related to implementation of the four habitat conservation strategies (northern spotted owl, riparian, marbled murrelet, and multispecies).

  Since ecological studies are conducted in response to DNR's management needs, they will benefit from **economic, social, and operational feasibility components** that support confidence that management strategies are viable business options and socially acceptable solutions. Stand-alone economic and social research are welcomed, although the expectation is that they will be conducted by external research partners. Operational trials, which will be described later in this chapter, are an important element of the OESF mission and are highly encouraged.

  Certain fundamental research studies, for example in the fields of taxonomy, evolutionary biology, and genetics, may be of high scientific interest, but inappropriate for adaptive management because they are not directly related to DNR's management needs. In other words, the information they produce likely will have relatively minor or indirect influence on management decisions. While valuable, such studies will not occur in the context of DNR's adaptive management process.

- Research and monitoring in the OESF are intended to have **broad implications for management of forested state trust lands**. To the appropriate extent, what is learned in the OESF, including paradigm

shifts, specific ecological knowledge, and improved management efficiencies, may be applied to management of other HCP planning units. For example, the OESF riparian conservation strategy described in the HCP was used in the development of the *Riparian Forest Restoration Strategy* for western Washington forested state trust lands (except the OESF) (Bigley and Deisenhofer 2006) and specifically in the guidance for thinning in riparian areas.

Types of Adaptive Management Used in the OESF

DNR uses two types of adaptive management in the OESF: passive and active (Walters and Holing 1990).

- Under passive adaptive management, information comes from monitoring a single course of action, most often a best management practice. Uncertainties and hypotheses around expected outcomes are identified, but no alternative management approaches are compared. If the monitored approach is deemed ineffective, alternatives may not be readily available. An example of a project implemented in passive adaptive management context is the Status and Trends Monitoring of Riparian and Aquatic Habitat in the OESF project (refer to "Near-Term Priority Research and Monitoring Activities" later in this chapter).

- Under active adaptive management, alternative management approaches are developed to achieve specific goals, and these alternatives are implemented and monitored to determine which is the most effective. DNR recognizes that experimental manipulation provides the strongest inferences about cause-and-effect relationships, and therefore has the highest value as an information source for adaptive management. However, the high cost and logistical difficulties associated with field experiments limit their scale and number (Lindenmayer and Franklin 2002). An example of a project implemented in the active adaptive management context is the Long-term Ecosystem Productivity study, which compares the effects of different harvesting techniques, woody-debris retention levels, and plant species composition on tree and soil productivity (refer to "Near-Term Priority Research and Monitoring Activities" later in this chapter).

Both passive and active adaptive management approaches are accepted by the Federal Services as appropriate when developing a strategy to

address uncertainties in HCPs (USFWS and National Marine Fisheries Service [NMFS] 2000).

Sources of Information for Adaptive Management

As adaptive management in the OESF is a science-informed process, most new information comes from research and monitoring, which are described in detail later in this chapter.

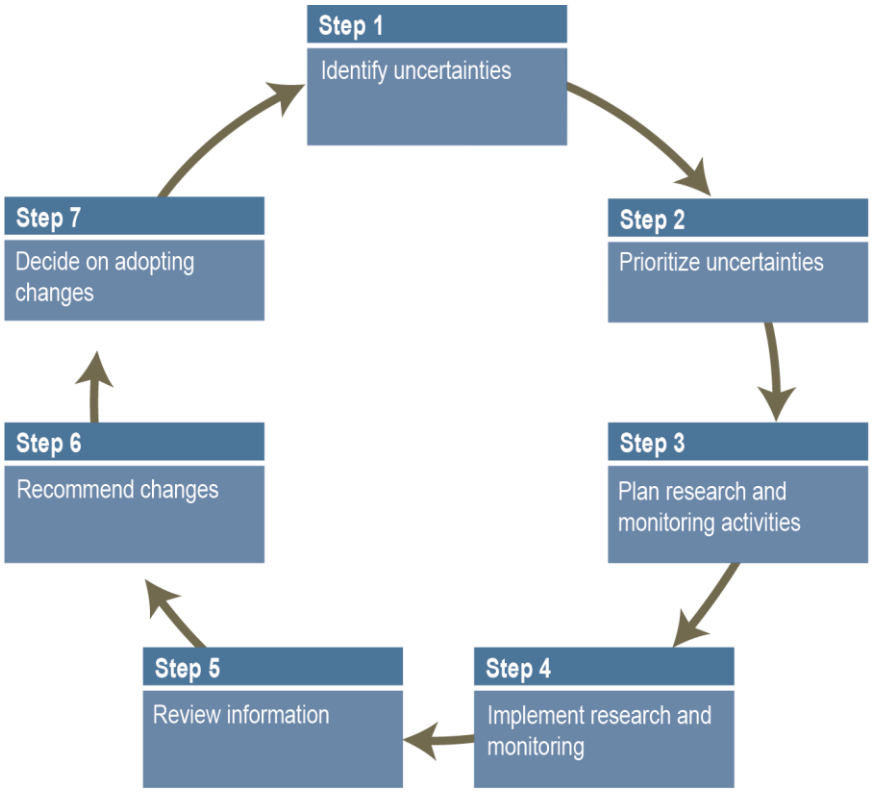
Along with Lindenmayer and Franklin (2002) and other authors, DNR supports the position that relevant knowledge for adaptive management also can be acquired from a variety of other sources, including modeling (for example, the OESF windthrow probability model described in Chapter 3) and operations. DNR views routine management operations and management experience as an important source of information for adaptive management. For many resource management problems, using management in an experimental, learning-oriented context is optimal for gaining the understanding needed to manage more effectively (Williams and others 2007). Under this holistic approach, recommendations for adaptive management are made after interpreting a range of information sources.

DNR uses not only information generated through DNR-sponsored and/or-led monitoring and research, but also new knowledge acquired by other organizations and research partners. The HCP recognizes that "other organizations may sponsor work that will generate the knowledge needed" and that DNR needs "to stay in touch with other Pacific Northwest research programs and assimilate information that can be used to meet HCP information needs" (DNR 1997, p. V.9).

The Adaptive Management Process

The adaptive management process in the OESF is illustrated in Figure 4-2. DNR implements this process through PR 14-004-530, *Adaptive Management in the OESF HCP Planning Unit*, found in the forestry handbook on DNR's intranet.

Figure 4-2. Adaptive Management Process in the OESF



Some steps in the adaptive management process are carried out by the Adaptive Management Advisory Group, Science Advisory Group, or DNR decision makers.

- The **Adaptive Management Advisory Group** includes Forest Resources assistant division managers, the Olympic Region state lands assistant and Coast District manager, and the OESF research and monitoring manager.
- Membership in the **Science Advisory Group** is not permanent; participating experts are carefully selected for each project based on their professional credentials in a particular subject area. Members include three scientific experts on the subject being reviewed and the OESF research and monitoring manager or a DNR scientist leading the study being discussed.

- **Decision makers** vary depending on the type and magnitude of the proposed changes to management and may include the Board of Natural Resources, members of DNR's executive management team, the Forest Resources Division Manager, and the Olympic Region Manager.

The roles and responsibilities of these groups will be explained briefly in the following steps. For a more complete explanation, refer to PR 14-004-530.

►Step 1, Identify Key Uncertainties

During development of this forest land plan and its environmental analysis, DNR compiled an initial list of key uncertainties about management of natural resources in the OESF and specifically about integration of revenue production and ecological values. Some uncertainties are broad in focus and date back to the HCP (DNR 1997); for example, the effectiveness of interior-core buffers to provide for riparian functions or the adequacy of northern spotted owl habitat thresholds in each landscape. Other uncertainties are more specific, for example the rate of tree regeneration in the small forest openings with high edge density created through variable retention harvest and variable density thinnings.

The list of key uncertainties, their relevance to DNR management objectives, and examples of research questions that are raised to help reduce key uncertainties can be found in the OESF Living Library on DNR's intranet. DNR expects the list to change over time as new knowledge is acquired or new uncertainties are identified. For example, uncertainties related to management of marbled murrelet habitat will be identified during development of the long-term marbled murrelet habitat conservation strategy. Going forward, updating key uncertainties will be the responsibility of the Adaptive Management Advisory Group.

The list of uncertainties is used in the prioritization process (Step 2 of the adaptive management process). DNR also provides the list to potential research partners and collaborators to guide the development of project-specific research questions and testable hypotheses.

Given the complexity of natural resource management in general and the experimental nature of the OESF management strategies in particular, the list of uncertainties can be very long. DNR restricted the list per the scope of adaptive management (described earlier in this chapter) and the geographic area (state trust lands in the OESF). The resulting key uncertainties are organized by 10 ecological themes (Table 4-1) which are inter-dependent.

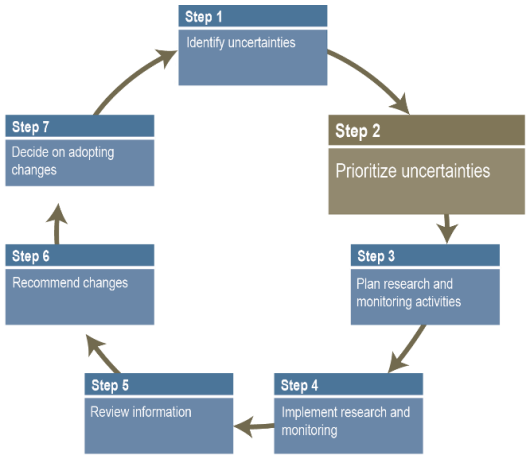
Table 4-1. Themes Used to Organize Uncertainties

	Theme	Relevance to Management Improvement
1	Use of silviculture to integrate revenue production and ecological values	DNR uses silviculture to create and maintain a biologically diverse working forest to support revenue production and ecological values, including habitat for native species. Many aspects of DNR's planned silvicultural activities are untested. DNR could benefit from more information on how the forest may respond to these activities.
2	Use of remote sensing for inventory and environmental monitoring	New remote-sensing techniques (for example, light detection and ranging [LiDAR]) have been developed to assess site and forest conditions for planning, inventory, and monitoring purposes more completely and at a lower cost than traditional methods. DNR could benefit from increased understanding about the feasibility and best practices for these techniques, and the types of metrics that can be applied to the data collected.
3	Ecological effects of forest roads	Projects completed under road maintenance and abandonment plans, new road construction per the forest practices rules and the Forest Practices Board Manual, and other management practices are expected to minimize the delivery of fine sediment to streams. DNR will benefit from increased understanding of the ecological and cost effectiveness of these practices.
4	Ecological effects of endemic winds	Wind is major natural disturbance factor in the OESF. DNR will benefit from better understanding the influence of forest management on wind firmness, the threshold for severe endemic windthrow risk used in the OESF windthrow probability model, and how best to account for windthrow in tactical model projections.

	Theme	Relevance to Management Improvement
5	Management of unstable slopes and headwater streams	DNR defers potentially unstable slopes or landforms in its tactical model and makes decisions on whether or not to harvest in these areas on a case-by-case basis consistent with the forest practices rules. DNR will benefit from both improving the effectiveness of its screening tools to identify these areas, and investigating the possibility of managing these areas without increasing the frequency and severity of landslides. DNR also will benefit from a better understanding of how forest management affects headwater streams on stable ground, on which DNR does not apply an interior-core or exterior wind buffer, and of how management activities affect soils susceptible to compaction, displacement and erosion in these and other areas.
6	Measurable thresholds for ecological values	A key concept that underlies DNR's riparian conservation strategy is to "conserve habitat complexity as afforded by natural disturbance regimes on the western Olympic Peninsula." Under the northern spotted owl conservation strategy, DNR restores and maintains threshold proportions of Old and Young Forest Habitat in each landscape. Quantifying habitat complexity (for the former) and improving the habitat definition of Old Forest (for the latter) will improve DNR's ability to monitor these areas and ultimately attain conservation objectives.
7	Ecological processes in a working forest	A better understanding of ecological processes, such as the decay of snags and down wood, and ecological relationships such as fish and wildlife species habitat associations will allow DNR to better plan, model, and monitor forest management activities and practices for attainment of revenue and ecological objectives.
8	Fish and wildlife species' response to forest management	Assessing the response of fish and wildlife to forest management is the ultimate validation of the HCP conservation strategies and the assumption "if we build it they will come."

	Theme	Relevance to Management Improvement
9	Planning from a landscape perspective	Uncertainties exist around the landscape distribution of habitat (for example, the optimal spatial configuration of northern spotted owl habitat) and the economic feasibility of the spatial distribution of management activities (for example, effects of road costs on harvest scheduling). Increasing DNR's understanding of both could lead to more efficient and effective attainment of revenue and ecological objectives.
10	Climate change and carbon budget	The specific effect of climate change on forest growth, species composition, resiliency, and distribution are largely unknown but may impact the agency's ability to meets its revenue and ecological goals. A better understanding of these potential effects could help DNR prepare for climate change.

►Step 2, Prioritize Uncertainties



The Adaptive Management Advisory Group prioritizes uncertainties for reduction per DNR's most relevant, pressing management needs using the prioritization criteria in Text Box 4-3. Prioritization helps DNR determine where to put efforts and resources first, and ensure an objective and transparent selection process. The prioritization process itself is described in the adaptive management procedure (PR 14-004-530, found in the forestry handbook). As uncertainties are prioritized, some may be dropped from consideration.

Text Box 4-3. Prioritization Criteria

1. **Linkage to future decisions**

   DNR will explore whether research and monitoring information gathered to reduce an uncertainty is likely to influence management decisions. Uncertainties that increase DNR's knowledge but have little or no relevance to management needs will be prioritized lower than those that are more relevant.

2. **Level of impact to revenue and conservation objectives**

   For this criterion, DNR will review the level of impact to revenue and ecological objectives associated with each uncertainty. The level of impact is a function of how severe the impact may be and how likely it is to occur. The level of impact can be quantified through sensitivity analyses of proposed management actions.

3. **The degree of uncertainty**

   DNR will evaluate the nature and degree of uncertainty about the ecological system in question through a combination of research synthesis and expert opinion. DNR also will consider the relevance of each uncertainty to the information needs specified in the monitoring and research sections of the HCP (p. V.1 through V.8) and the adaptive management section of the HCP Implementation Agreement (p. B.10 through B.11).

4. **Feasibility of getting answers in a reasonable time and at a reasonable cost**

   Whether an answer can be obtained in a reasonable time and at a reasonable cost depends on both the complexity of the ecological system and how long it may take that system to respond. Appropriate questions when applying this criterion are as follows: *Can cost-effective research and monitoring techniques be developed to reduce the uncertainty?* W*hat degree of rigor of research and monitoring is needed to influence future decisions, and can this rigor be achieved?*

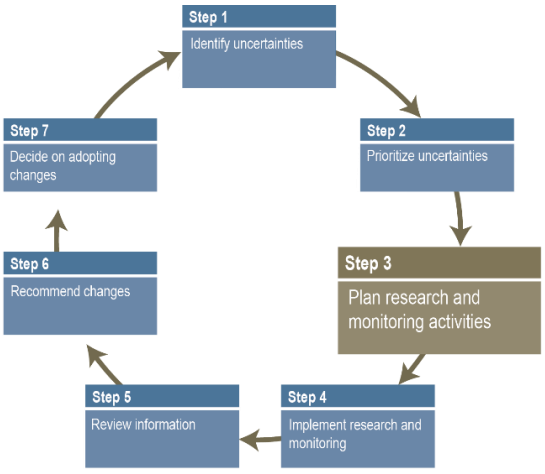
   Similar to Criteria 3 (degree of uncertainty), feasibility is best evaluated through expert opinion. Whether judgments are made qualitatively or quantitatively is less important than having those judgments explicitly stated (Failing and others 2004).

5. **Can research and monitoring conducted by different agencies and other sources be tapped?**

   Often, it is more efficient and cost-effective to gather information in collaboration with other researchers. If others are already addressing an uncertainty, it may become a priority for DNR. By working with others, DNR will have an opportunity to obtain the necessary information at lower cost, in a shorter time, or both. If others are already addressing a key uncertainty and reduction of that uncertainty can contribute to DNR's management needs, the priority rank of this uncertainty may be elevated. For example, DNR participates in a number of regional research cooperatives that address specific uncertainties related to tree spacing and growth rates, the climatic and edaphic controls on productivity, long-term sustainability, vegetative competition effects, and other topics that may contribute to reducing the uncertainties described for the OESF.

At this step, the Adaptive Management Advisory Group also discusses potential ways to reduce priority uncertainties; appropriate research and monitoring questions, similar to the examples in the key uncertainties list in the living library; key hypotheses to be tested; study approaches; and other issues. Scoping papers that outline the studies or brief project proposals may be submitted for consideration at this step.

►Step 3, Plan Research and Monitoring Activities

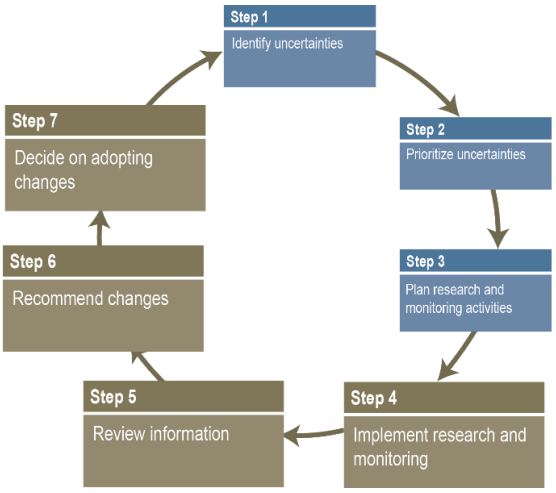


In this step, DNR develops specific research and monitoring projects to reduce the uncertainties prioritized in Step 2. Project planning starts with formulating specific research questions and developing a project proposal or scoping paper. Once DNR support for the project proposal is secured from decision makers, the principal investigator(s) develops a study plan which includes objectives, refined research questions, testable hypotheses, study design, field protocols, and analytical methods. The study plan also describes how results may inform future management

decisions. Selection of field sites requires involvement of managers at various levels depending on the size, location, and type of proposed treatments. As part of this step, DNR may consider the potential for external funding (through grants and research partnerships) and the opportunity for collaborative monitoring and data sharing.

DNR's Science Advisory Group(s) meets as needed to peer-review, and in some cases develop study plans.

►Step 4, Implement Research and Monitoring



In Step 4, DNR implements the research and monitoring projects developed in Step 3 or conducts those projects through research partnerships and other forms of collaboration. In most cases, research and monitoring projects and consideration of results by decision makers span more than one adaptive management cycle. This is especially true for ecological systems such as forests that change very slowly.

►Step 5, Review New Information

In Step 5, the Adaptive Management Advisory Group reviews and interprets research and monitoring findings from Step 4, as well as other scientifically-credible information from outside sources.

The Science Advisory Group(s) often peer-reviews externally-produced information and reports from DNR projects. Members of this group may be asked to explain results to the Adaptive Management Advisory Group.

At this step, external organizations may request a change in land management. The Adaptive Management Advisory Group considers these requests and may seek scientific review on them.

►Step 6, Recommend Adaptive Management Changes to Decision Makers

In Step 6, the Adaptive Management Advisory Group formulates adaptive management recommendations for DNR decision makers. The group bases their recommendations on the findings from Step 5 but also considers the economic and social consequences and operational feasibility of potential changes.

►Step 7, Make Decisions on Adaptive Management Changes and Implement

In this final step, decision makers decide whether to adopt proposed adaptive management changes. They may direct a specific management change to be implemented (which may be a modification of the recommended change), make an informed decision not to change current management practices, or request more information. Potential changes may include an update or amendment to a policy or planning document (for example, the HCP or the OESF forest land plan, respectively), new or updated procedures (such as those found in the Forestry Handbook), change in operational guidelines, new or updated training in natural resource management, or organizational changes. Some of these changes may require SEPA review, for example if a proposed change falls outside the range of alternatives analyzed in the environmental impact statement for this forest land plan. If management changes are adopted, DNR decision makers ensure DNR has the financial means and organizational structure to implement them.

Information is documented during all steps of the adaptive management process through meeting notes, recommendation reports, or other documents as needed. These documents will be stored in the OESF Living library.

Research and Monitoring

A science-informed adaptive management process relies primarily on research and monitoring to provide new, relevant, and reliable information for increasing confidence in current management or developing new management options. The Federal Services identify research and monitoring as one of the key components of a meaningful adaptive management process (USFWS and NMFS 2000):

> [Key components include] careful planning through identification of uncertainty, incorporating a range of alternatives, implementing a sufficient monitoring program to determine success of the alternatives, and a feedback loop from the results of the monitoring program that allows for change in the management strategies.

If an HCP has an adaptive management provision, as it is the case with DNR's HCP, the Federal Services consider integrating the monitoring program into adaptive management as "crucial in order to guide any necessary changes in management" (USFWS and NMFS 2000).

Types of Monitoring

Research and monitoring are both scientific activities that answer questions through systematic, objective, empirical testing of hypotheses. The difference between them lies in their goals:

- The primary goal of research is to acquire fundamental knowledge about natural phenomena and to develop innovative management practices.
- The primary goal of monitoring is to provide information about management operations (Wilhere and Bigley 2001).

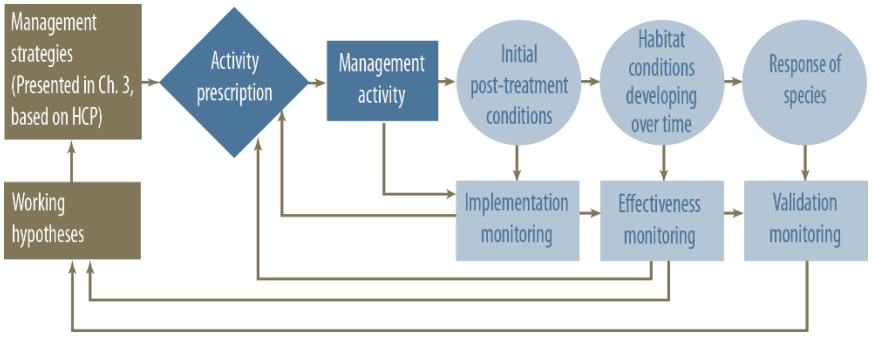
The HCP described three types of monitoring to be conducted in the OESF (DNR 1997, p. V. 3-5):

- **Implementation monitoring**, used to determine whether the HCP conservation strategies are implemented as written;
- **Effectiveness monitoring**, used to determine whether implementation of the conservation strategies results in anticipated habitat conditions; and
- **Validation monitoring,** used to evaluate cause-and-effect relationships between habitat conditions resulting from implementation of conservation strategies and the salmonid and northern spotted owl populations these strategies are intended to benefit.

Different types of monitoring involve different levels of complexity, and all three types are essential elements of an adaptive management program (Lindenmayer and Franklin 2002). Inferences made at a higher, more complex level (for example, effectiveness monitoring) depend on results at a lower level (implementation monitoring).

Figure 4-2 shows the relationship between the three types of monitoring and their effects on forest management.

Figure 4-2. Relationship between Implementation, Effectiveness, and Validation Monitoring and Forest Management
Modified From Wilhere and Bigley 2001



Activity prescriptions are written for **management activities** such as silvicultural treatments. Those prescriptions are based on management strategies (refer to Chapter 3), which are based on the conservation strategies in the HCP.

After a **management activity** has been conducted, DNR evaluates it through **implementation monitoring**. DNR determines whether or not the activity is implemented as described in the prescription, and whether the **initial post-treatment conditions** are in compliance with the requirements of the HCP. For example, DNR documents the number of leave trees remaining after harvest and the threshold proportions of northern spotted owl habitat remaining in the landscape.

Through **effectiveness monitoring**, DNR evaluates **habitat conditions developing over time** after a management activity or series of activities. For example, DNR monitors the rate at which stands treated with variable density thinning develop structural diversity. The results from both implementation and effectiveness monitoring are expected to inform the development of future management prescriptions.

Through **validation monitoring**, DNR evaluates the **response of species** to a management activity. For example, DNR may evaluate the change in species composition and survival of salmonids in response to variable retention harvests across a watershed. In this step, DNR utilizes information about habitat conditions collected through effectiveness

monitoring and information about species habitat needs. The results from validation monitoring support or reject DNR's **working hypotheses** and therefore also would inform the **management strategies** based on those hypotheses.

Categorizing monitoring by types helps to illustrate the scope and purpose of monitoring. However, these categories are not discrete; they can overlap. For example, the HCP does not distinguish status and trends monitoring as a separate category. Since the ultimate goal of tracking and evaluating long-term changes in habitat is to link such changes to the implemented management strategies, status and trends monitoring falls under the broader category of effectiveness monitoring.

Near-Term Priority Research and Monitoring Projects

As of September 2016, DNR has identified the following research and monitoring projects and programs as high priorities in the near term (within the next five years). Topics are not listed in order of priority.

- Implementation monitoring
- Status and Trends Monitoring of Riparian and Aquatic Habitat in the OESF
- Silvicultural experimentation to develop structurally complex forests
- Cooperative silvicultural research
- Validation monitoring of the HCP riparian conservation strategy
- Long-Term Ecosystem Productivity Study
- Large-Scale Integrated Management Experiment

As DNR engages in a formal adaptive management process, the priority status of these projects will be evaluated annually and new projects likely will be added to the list.

Several of the projects described in this section, namely the Status and Trends Monitoring of Riparian and Aquatic Habitat project, silvicultural experimentation, and the Large Scale Integrated Management Experiment, help DNR meet its HCP commitment for effectiveness monitoring. DNR may consider other projects, for example the effectiveness of thinning to create or accelerate development of northern spotted owl habitat, as future priorities for effectiveness monitoring.

Following is a brief description of each project. Details and project documents are available on DNR's external website at

http://www.dnr.wa.gov/programs-and-services/forest-resources/olympic-experimental-forest/ongoing-research-and-monitoring.

►Implementation Monitoring

DNR conducts implementation monitoring on a sample of its forest management activities across state trust lands every year. The majority of this monitoring is done to satisfy the requirements of the HCP (DNR 1997, p. V.1-9). The focus of HCP implementation monitoring is primarily on timber harvest and road management activities. However, other forest and non-timber management activities that may affect the outcome of the conservation strategies also are subject to implementation monitoring. Examples include silvicultural activities such as site preparation, vegetation management, and pre-commercial thinning.

In addition to demonstrating compliance with the HCP, data from OESF implementation monitoring is needed for the following:

- **HCP effectiveness and validation monitoring and research.** Information on completed activities and the assessment of immediately resulting habitat conditions is used to characterize baseline ecological conditions and to conduct retrospective studies such as the effectiveness of exterior wind buffers.
- **Adaptive management.** Findings of non-compliance and their causes is used to continuously improve management.
- **Reruns of the tactical model.** Updates on completed activities and resulting ecological conditions will improve model input data.
- **Communication with DNR stakeholders and research partners.**
- **Other DNR programs such as forest certification.**

Past implementation monitoring projects (starting in 2001) have included northern spotted owl habitat maintenance treatments, management activities in wetlands and wetland management zones, riparian restoration treatments, and retention of large, structurally unique trees and snags (implementation monitoring reports are available on DNR's website at http://www.dnr.wa.gov/programs-and-services/forest-resources/habitat-conservation/monitoring-and-reporting).

Future implementation monitoring projects in the OESF likely will revisit previously monitored strategies, since past strategy compliance does not assure future compliance. Future implementation monitoring projects may include new management strategies because

implementation risk is elevated if staff are implementing something for the first time.

In the future, DNR may increase its use of remote sensing data (for example, LiDAR-derived datasets) and other datasets for office audits. More information on the implementation monitoring approach in the OESF and its organization and funding is provided in the OESF Living Library.

►Status and Trends Monitoring of Riparian and Aquatic Habitat in the OESF

Through this project, DNR documents how riparian and aquatic habitat conditions change across OESF over time as this forest land plan is implemented. In its environmental analysis for this forest land plan, DNR projected gradual improvement in riparian and aquatic conditions (DNR 2016). Monitoring allows DNR to test this projection with empirical data and help reduce key uncertainties about ecological relationships between in-stream, riparian, and upland areas. DNR uses monitoring data to characterize baseline habitat conditions and habitat variability, both of which are used in riparian validation monitoring (monitoring fish response in managed landscapes; refer to "Validation Monitoring for the HCP Riparian Conservation Strategy" later in this section). In addition to gathering data on the status and changes over time of multiple habitat indicators, DNR makes inferences about management effects on riparian and aquatic habitat across the OESF through an analytical approach called "model-based inference" (Burnham and Anderson 2002).

Following the 2012 study plan (Minkova and others 2012), long-term (at least 10 years) monitoring sites were established in 50 Type-3 watersheds representative of riparian conditions across the OESF. DNR is sampling seven aquatic habitat indicators (channel morphology, channel substrate, stream temperature, shade, discharge, in-stream large wood and habitat units such as pools or riffles) and two riparian habitat indicators (microclimate and riparian vegetation) at the outlet of each watershed. DNR is providing the majority of the funding and logistical support for the study. The USFS Pacific Northwest Research Station, a key collaborator on this project, is providing scientific expertise, field support, and additional funding.

►Silvicultural Experimentation to Develop Structurally Complex Forest

A major impetus for designating the OESF was to experiment with silvicultural techniques for integrating revenue production and ecological values. For example, DNR uses variable density thinning to create gaps in the forest canopy to increase structural diversity, and also uses pre-commercial thinning to bypass the structurally simple, "competitive exclusion" stand development stage and set the stand on a trajectory to develop elements of structural complexity such as more than one canopy layer (refer to Chapter 2 for more information). Both of these activities were meant to create and maintain a biologically diverse working forest that provides quality timber for harvest as well as habitat for native species, as described in Chapter 2.

Two ongoing research projects address uncertainties related to silviculture:

- **Mind the Gap: Developing Ecologically Based Guidelines for Creating Gaps in Forest Thinning on the Olympic Peninsula**: This study combines remote sensing and field data to better link silvicultural gap treatments with the late-successional forests they aim to emulate. The study is conducted in three phases: 1) a retrospective study of gaps created over 10 years ago, to understand ecosystem response; 2) an observational study of natural gap structures in primary mature and old-growth forests (primary forests are forests that developed after natural disturbance and have never been logged), to establish critical reference information; and 3) a replicated silvicultural experiment to test novel gap treatments (informed by the structures found in primary forests) within a variable density thinning treatment. Response variables include tree recruitment, understory vegetation response, branching and crown responses, decadence (dead wood) creation around edges, and post-treatment dynamics of gap contraction and expansion (for example, windthrow). Funding is provided by DNR.

- **Influence of Repeated Alternative Biodiversity Thinning Treatments on Coastal Forests:** This study evaluates the effects of repeated thinning on wood production and wildlife habitat. The stands included in the experiment was first thinned in 1999. Funding is provided by DNR.

►Cooperative Silvicultural Research

Two long-term studies conducted through DNR's participation in silvicultural research cooperatives (co-ops) have installations in the OESF. These two studies are replicated regionally and have broad management implications but also provide information relevant to specific OESF management questions. (For a description of research co-ops, refer to "Research Partnerships" later in this chapter.)

In the first study, the Stand Management Co-op (based at University of Washington) is investigating the performance of Douglas-fir in relation to a wide range of tree spacing and density levels. In relation to HCP objectives, the study is investigating crown and branch development, tree stability, and growth and yield in relation to tree spacing. Large treatment blocks in the OESF were planted at various spacings in the mid-1990s and study plots are re-measured every five years. This installation in the OESF is one of 47 installations, comprising over 550 permanent plots, scattered across the Pacific Northwest.

In the second study, the Hardwood Silviculture Co-op (based at Oregon State University) is investigating red alder establishment and growth in relation to spacing, thinning, and pruning at two locations. This study provides DNR with insights into managing stands for a diversity of tree species as an alternative to even-aged conifer stands. A diversity of tree species is expected to contribute to biodiversity in the OESF. The data from this study has been used to develop the first growth and yield model of plantation red alder and techniques for planting and managing red alder successfully. Study plots were installed in 1991 and 1996 and are re-measured at three to five year intervals. The study has been replicated at 26 locations on multiple ownerships across the Pacific Northwest.

Measurement responsibility for these two studies is shared between DNR and Co-op staff, while analysis is largely conducted by Co-op staff at their respective universities. Results are shared with DNR and often published in peer-reviewed literature (refer to "Research Partnerships" for more information on co-ops).

►Validation Monitoring for the HCP Riparian Conservation Strategy

Riparian validation monitoring, which is to occur only in the OESF, is an HCP commitment. Incomplete knowledge about the habitat needs of riparian and aquatic species, and specifically salmonid species, as well as their response to management, have been identified as key uncertainties.

Two riparian validation monitoring approaches (observational and experimental) are described in DNR's draft study plan (Martens in prep). Under the observational approach, management effects, habitat, and

salmonid conditions (for example, the abundance, biomass, species composition, age structure, and (or) number of spawning redds) are assessed over time within the 50 Type-3 watersheds selected for Status and Trends Monitoring of Riparian and Aquatic Habitat (described earlier in this section). The observational approach explores a potential range of management effects over much of the OESF, recognizing that salmonid conditions may be influenced by multiple factors (for example, ocean and freshwater harvest, climate change, and natural disturbances) that may confound the results. Under the experimental approach, treatment (management actions) and control sites are installed in a paired-basin design to evaluate the habitat and salmonid response to specific management actions over a limited area. Implementation of individual experimental studies depends on information gathered under the observational approach; the collected observational data is evaluated on a 6-year rotation.

DNR conducted a pilot fish survey in the 50 Type-3 watersheds used in the Status and Trends Monitoring of Riparian and Aquatic Habitat project in 2015 and started to implement the observational monitoring approach in 2016. Funding is provided by DNR. USFS Pacific Northwest Research Station, NOAA Fisheries, and the United States Geological Survey (USGS) are providing scientific expertise.

►Long-Term Ecosystem Productivity Study

The OESF is host to one of four replicates of the Long-Term Ecosystem Productivity Study (the other 3 are in Oregon), which is led by the USFS Pacific Northwest Research Station. This study evaluates the effects of different silvicultural treatments on long-term ecosystem productivity, including carbon dynamics, by measuring vegetation response and conducting soil analysis.

The OESF installation was established and treatments were implemented in 1996. Silvicultural treatments included clearcutting; leaving woody debris; thinning to accelerate late-seral stage forest development, favoring early-successional species; and planting monocultures of Douglas-fir. Post-treatment measurements and later re-measurements of the plots, included vegetation and soil sampling are ongoing. Funding is provided by DNR, USFS Pacific Northwest Research Station, and University of Washington.

►Large-Scale Integrated Management Experiment

DNR and the University of Washington's Olympic Natural Resources Center are developing a proposal to implement a long-term, landscape-level management experiment in the OESF to evaluate the ecological and economic feasibility of the integrated management approach. Researchers will compare a no-action control and integrated management applied at three different intensities across a selection of Type-3 watersheds: 1) Integrated management as represented by this forest land plan; 2) Integrated management that is less conservative (higher risk but potentially higher return) than represented in this forest land plan, with more intensive silvicultural activities in more managed areas within the watersheds selected for experimentation; and 3) Integrated management that is more conservative (lower risk with potentially lower return) than represented in this forest land plan, with more areas restricted from harvest within the watersheds selected for experimentation.

Response variables are derived from consideration of past and potential future management decisions and include ecological effects, economic returns, and assessment of operational feasibility. DNR and the University of Washington's Olympic Natural Resources Center envision participation of stakeholders at all stages of the study and multiple research partnerships. A detailed study plan will be developed and peer-reviewed after support for this proposal is secured.

Research Partnerships

Because DNR has limited resources to dedicate to research and monitoring, successful implementation of its research and monitoring program relies on partnerships with other research institutions, organizations, and individuals who have relevant areas of expertise. Strong partnerships between DNR and other research institutions are expected to increase the visibility of OESF, attract external funding, and effectively implement research and monitoring studies that meet DNR's management needs and fulfill HCP commitments.

DNR has used different partnership models over the years ranging from contracts on specific projects to long-term cooperatives. Following is a description of two of these partnerships.

►Silvicultural Research Co-ops

DNR participates in several long-term, regional silvicultural research studies investigating forest stand development and dynamics with silvicultural research co-ops.

Co-ops are university-based organizations with a tenure-track professor hired as the director. They are funded through dues paid by the membership which typically represents most of the larger organizations managing forest land in the Pacific Northwest, including agency, industrial, and private owners. In most cases, field studies are installed on member lands. They are replicated on-site and regionally, thus providing a robust statistical design that spans a wide range of environmental conditions. Measurement responsibility is generally shared between members and co-op staff, while analysis is largely conducted by co-op staff at their respective universities. Results are shared with members and often published in peer-reviewed literature.

Co-op studies improve DNR's understanding of the fundamental growth dynamics of trees in relation to growing space and other considerations. Such knowledge will better enable DNR to devise new silvicultural approaches, for example ways to create the complex stand structures that define northern spotted owl habitat. Furthermore, the growth models developed in these types of studies better enable DNR to forecast future stand development, a necessary part of planning.

►National Experimental Forest and Range Network

In 2009, the OESF joined the Experimental Forest and Range Network. This national network includes 70 experimental forests and ranges, and is coordinated by USFS to encourage data-sharing and to promote collaborative research. Participation in the network provides DNR the opportunity to increase visibility for the OESF within the nationwide research community, access scientific expertise and science leadership provided by the Pacific Northwest Research Station, participate in other research and data-sharing networks, and benefit from the technology transfer being done in the network.

Operational Trials Program

With adoption of this forest land plan, DNR implemented a new program of operational trials in the OESF. Operational trials are ideas proposed by DNR staff that explore new operational techniques or methods within the context of current management strategies. For example, these trials may involve new yarding techniques, new logging methods, or new ways to meet typical logging contract requirements such as avoiding damage to leave trees. Some trials may explore ways to make restoration thinnings, such as those proposed to create or accelerate northern spotted owl habitat development, more operationally and economically feasible. Ideas for operational trials could be sparked by experience, trade shows, conferences of professional organizations, articles, or other interactions and opportunities.

Operational trails are meant to be agile, implemented in a short time frame and typically small in scale (such as an individual timber sale). They are meant to provide DNR staff the opportunity and space to innovate and are well suited to DNR's mission of intentional learning. Outputs from this program may include basic white papers or other simple reports that are distributed throughout DNR.

Operational trials are linked to the research and monitoring program in the following ways:

- All operational trials are included in DNR's research and monitoring database, which is available through the OESF Living Library on DNR's intranet.
- Depending on the geographic scale and/or potential impacts of the proposed operational trial, it may be elevated to a formal research project with a study plan, in which case it would be implemented through the research and monitoring program, not as an operational trial.
- A completed operational trial may result in findings that warrant more formal scientific exploration, in which case the operational trial may be elevated to a formal research study with a study plan.

Communication and Outreach and Information Management

Communication and outreach and information management are critical components of the research and monitoring program in the OESF and affect the overall success of the adaptive management process. The HCP considered them as key processes for implementing integrated management (DNR 1997 p. IV. 85). These topics are covered in Chapter 2 of this forest land plan.

Planning for Success

While developing the adaptive management process, the adaptive management procedure, and the structure of the OESF research and monitoring program, DNR drew upon lessons learned from past efforts, the successes and challenges faced by other regional land managers, and review of the best available science on adaptive management of natural resources. In 2015, DNR organized an adaptive management workshop and invited practitioners from state, federal, and private organizations in the Pacific Northwest to share their experience in implementing adaptive management and promoting practices for successful implementation. The results of these efforts are summarized in two white papers available in the OESF Living Library on DNR's intranet.

What has emerged from this assessment is a clear understanding of both the challenges DNR is likely to face in implementing the OESF adaptive management process and the ways to meet those challenges: a robust research and monitoring program with clearly defined and prioritized uncertainties linked to land management needs, a well-established administrative structure, and an institutionalized, step-by-step adaptive management process. DNR's recent accomplishments in these areas build confidence in the future of adaptive management in the OESF.

[1] When an activity raises threats of harm to the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context, the proponent of an activity, rather than the public, should bear the burden of proof (Science and Environmental Health Network 2000).

5

Glossary

Brief definitions of key terms used in this forest land plan

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Glossary

A

Active management: Intervening in the development of a forest stand through planting, thinning, managing competing vegetation, harvesting, or other stand management activities. In the context of the management pathways for implementation of the northern spotted owl conservation strategy, active management means thinning.

Adaptive management: A formal process for continually improving management practices by learning from the outcomes of operational and experimental approaches (Bunnel and Dunsworth 2009).

Age class: A grouping of trees in the same age group used to simplify data that describes age composition for a stand or landscape. Age classes are often divided into decadal groups to portray the distribution of tree ages within a stand, or stand origin dates on a landscape.

B

Basal area: The cross-sectional area of all stems in a stand measured at breast height. Generally expressed in square feet per acre.

Biodiversity: The full range of life in all its forms (Washington Biodiversity Council).

Biodiversity pathways: An approach to achieving goals of biodiversity and conservation while also supporting revenue production in managed stands that was popularized by research biologist Andrew Carey. Biodiversity pathways consists of the following principles: retention of biological legacies at harvest (snags, down wood, large trees, and other features) and soil organic matter; pre-commercial thinning to bypass the competitive exclusion stage and promote woody plant diversity; thinning at variable densities to promote heterogeneity; natural regeneration of western hemlock, western redcedar, and deciduous trees; and longer rotations (70-130 years).

C

Cable logging. A logging technique in which logs are transported from where they are harvested to a landing using a suspended cable.

Catastrophic windthrow: Windthrow that results from strong peak winds that occur infrequently (more than 20 years between occurrences). Such winds can damage timber across a large area, including both interior forest stands and forest stands with exposed edges.

Clearcut: According to Washington state forest practices rules, a harvest method in which the entire stand of trees is removed in one timber harvesting operation.

Codominant: A tree whose crown forms the general level of the canopy and receives light from above and little from the sides (Tappeiner II and others 2007).

Cohort: Portions or attributes of a forest stand that can be defined and managed for, such as large live legacy trees, discrete age classes, snags, or down wood.

Cohort management: A silvicultural system based on the simultaneous management of multiple cohorts within an area to meet objectives.

Commercial thinning: A thinning that generates revenue and is performed to meet a wide range of objectives including improving the growth of the stand, enhancing stand health, reducing tree mortality, or accelerating the development of habitat.

Competitive exclusion: A stand development stage in which trees fully occupy the site and compete closely for light, water, nutrients, and space. This stand development stage typically lacks the understory, snags, down wood, and other elements of structural diversity that characterizes more mature stages. *See* stand development stage.

D

Detectible increase in peak flow: A 10 percent or more increase in peak flow over unmanaged conditions.

Demographic support: 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).

Diameter at breast height (DBH): The diameter of a tree measured 4.5 feet above the ground on the uphill side of the tree.

Dispersal: The movement of juvenile, sub-adult, and adult animals 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).

Dominant: A tree whose crown extends above the general level of the canopy and receives light from above and partly from the sides (Tappeiner II and others 2007).

E

Ecological values: The elements (for example, trees, wildlife, soil, and water) and natural relationships between these elements that are biologically and functionally important to the continued health of the forest ecosystem (DNR 1991).

Ecosystem resilience: Ability of an ecosystem to recover from disturbance.

Edge density: The ratio between the length of the harvest boundary and its area, which indicates the complexity of the harvest's shape.

Effectiveness monitoring: For the HCP, a system used to determine whether or not a management plan and its specific strategies are producing the desired habitat conditions.

Endemic windthrow: Windthrow that results from peak winds that occur fairly frequently (every five years or less).

Exterior wind buffer: Area adjacent to the interior-core buffer that protects the interior-core buffer from severe endemic windthrow.

F

Fen. A type of wetland that usually has sedge peat soils and is in contact with nutrient-rich ground and surface water. A seral stage of bogs.

Fetch: The length of the forest opening over which a given wind has blown. The longer the fetch and faster the wind speed, the more wind energy is imparted to the forest edge.

Forest estate model: A powerful, computer-based tool that enables DNR to consider the entire land base at once to find efficient and effective ways to balance multiple objectives. *See* tactical model.

Forest rotation: The time between planting or natural regeneration of a forest stand and stand replacement harvest.

Forest inventory data: A collection of measurements (such as tree height and diameter) made to calculate a set of forest attributes (such as trees per acre or basal area) at a particular point in time.

Forest Practices: The administrative branch of DNR responsible for regulating forest practices activities on all state and private forest lands.

Forest practices rules (Title 222 WAC): Standards for forest practices such as timber harvest and road construction.

Forest Practices Board Manual: An advisory technical supplement to the forest practices rules.

G

Goal: A desired outcome, but more specific than a vision. Goals are aspirational and worded generally to achieve broad aims, based on high-level policies (such as the HCP and *Policy for Sustainable Forests*), and are qualitative (not directly measurable). *See* vision.

Guy line: The cables that support the tower used in cable logging.

Guy line circle: A circle of trees that have been cut to avoid interference with the proper alignment, placement, or tightening of guy lines.

H

Habitat conservation strategy: Strategies in the HCP for managing specific types of wildlife habitat, such as riparian or northern spotted owl habitat.

Hardwood conversion. Replacing hardwood trees such as maple or alder with conifers.

Harvest schedule: A list of the recommended type, location, and timing of timber harvest; an expression of the tactical model's optimal solution

of when, where, and by what method to harvest stands across the land base and over time to meet multiple objectives.

Hydrologically mature forest: A forest with a canopy that is dense enough to intercept snowfall and often has enough vegetation to absorb water or slow its flow into the stream.

I-K

Implementation monitoring: A form of monitoring that determines whether or not a management plan (for example, the HCP) or its components are implemented as written.

Incidental take: The taking (harm) of a federally listed wildlife species, if such take is incidental to, and not the purpose of, carrying out otherwise lawful activities (DNR 1997).

Integrated management: An experimental management approach based on the premise that a working forest can be managed to provide both revenue (through timber harvest) and ecological values including healthy streams and forests and habitat for native wildlife species. This approach is different than the more common approach of dividing a forested area into large blocks that are managed for a single purpose, such as a nature preserve managed for ecological values and a working forest managed for revenue production.

Intentional learning: A planned and systematic learning process that focuses on a goal and is often directed by hypotheses. Intentional learning is different from incidental learning, in which learning is often unplanned and takes place sporadically, usually in association with certain occasions.

Interior-core buffer: A forested area adjacent to a stream managed to maintain riparian function and minimize adverse effects of upland management activities on riparian areas.

L

Landing: The place to which logs are carried for loading onto logging trucks.

Leave tree: A live tree left on a timber sale after harvest, intended to provide habitat and structure in the developing stand.

Long-term site productivity: The ability of an area to support plants and wildlife.

M

Maintenance and enhancement phase: The time between the attainment of the 40 percent Young Forest Habitat and better threshold and the end of the HCP permit period (2067).

Management approach. A broad framework for how to achieve a vision, such as integrated management.

Management pathway: A course of action for achieving a set of objectives for the northern spotted owl conservation strategy.

Management strategy. Specific steps DNR will take to implement each component of an HCP conservation strategy or other policy.

Measurable objective. A desired outcomes based on goals. Measurable objectives are used to evaluate whether DNR is meeting its goals.

Mission. A statement of purpose, based on an organization's values.

N

Natural area preserve (NAP): A state-designated area that protects a high-quality, ecologically important natural feature or rare plant and animal species and their habitat. It often contains a unique feature or one that is typical of Washington State or the Pacific Northwest.

Natural resources conservation area (NRCA): A state-designated area managed to protect an outstanding example of a native ecosystem or natural feature; habitat for endangered, threatened, or sensitive species; or a scenic landscape.

Net present value: A financial term referring to the sum of both current and future cash flow. It is the cash inflow (revenue from timber sales) minus cash outflow (costs of forest management).

Non-declining yield: A flow of goods or services that does not decrease in successive periods (Society of American Foresters [SAF] 2013). In the context of the riparian watershed assessment automated in the tactical

model, non-declining yield means the riparian forest's potential to provide large woody debris or shade to the stream either remains the same or increases over time.

O

Old Forest Habitat: A grouping of northern spotted owl habitat that supports all of the owl's life history requirements (roosting, foraging, dispersal, and nesting). Old Forest Habitat is an aggregate of Type A, Type B, and high-quality nesting habitat.

Old growth: Per DNR policy, forest stands of five acres or larger in the most structurally complex stage of development with a natural origin date prior to 1850.

P-Q

Passive management: Allowing a stand to develop without intervention. Active and passive management are deliberate silvicultural decisions.

Pathway: *see* **management pathway**.

Peak flow: Periods of high stream flow or maximum discharge, usually associated with storm events.

Planning from a landscape perspective: A multi-scale approach to planning that was recommended in the HCP as a means of implementing integrated management. This type of planning involves looking at the entire land base at different spatial scales to determine the best means of meeting multiple objectives over time.

Pre-commercial thinning: Removal of less desirable trees to maintain the growth and stability of retained trees. Pre-commercial thinning is performed before the trees are large enough to be marketable. This type of thinning does not generate revenue, and cut trees are left on site to decompose.

Procedure. Instructions for foresters completing tasks in the field. Procedures often are written to implement management strategies.

R

Reduction of uncertainty: Obtaining knowledge (information or data) that increases understanding of the existing system and/or confidence in future outcomes. Although many uncertainties can be reduced through scientific investigation, uncertainties cannot be eliminated completely.

Regeneration harvest: Also called a stand replacement or final harvest. The harvest that signifies the end of a forest rotation; the harvest of trees to make room for regeneration of a new forest stand.

Relative density (RD): A mathematically derived parameter that indicates the level of intra-stand competition between trees, and consequently, a theoretical optimal range for thinning. A commonly used version of RD is formally known as Curtis' RD after Bob Curtis, a United States Forest Service biometrician who developed the measure.

Reliable information: Information that can be trusted. In the strict scientific sense, "reliable" refers to *giving consistent results*. In the context of adaptive management, the term is used more broadly to mean *objective* and *accurate*.

Restoration phase: The time it takes a landscape to attain the 40 percent Young Forest Habitat and better threshold.

Riparian area: Where aquatic and terrestrial ecosystems interact. Riparian areas include surface waters such as rivers, streams, lakes, ponds, and wetlands, and the adjacent forests and groundwater zones that connect the water to the surrounding land.

Riparian management zone: An area of trees and shrubs adjacent to the stream managed to meet the objectives of the HCP riparian conservation strategy. It consists of an interior-core buffer and an exterior wind buffer.

Road maintenance and abandonment plan (RMAP): A plan that covers all forest roads on a landowner's property constructed or used for forest practices after 1974. It is based on a complete inventory that also shows streams and wetlands adjacent to or crossed by roads. The plan lays out a strategy for maintaining existing roads to meet state standards and shows areas of planned or potential road abandonment.

Rotation: The period between regeneration of a stand (through planting or natural regeneration) and final harvest.

Rutting: A furrow or groove in the soil.

S

Severe endemic windthrow: Endemic windthrow that results in significant loss of riparian function, such as substantial reductions in shade.

Silviculture: The art and science of managing forests to accomplish objectives.

Silvicultural activity: Actions directed at assessing or controlling the harvesting, regeneration, composition, growth, structure or other attribute of a forest stand. Specific activities include site assessments, evaluations, site preparation, planting, vegetation control, thinning, and harvesting. Silvicultural activities are often referred to as treatments.

Silvicultural objectives: A desired future state that is defined through discrete measurable parameters, such as desired stocking levels, or percent of ground covered by down wood. Silvicultural objectives are based on stand- and landscape-level capabilities, and may be related to any valued forest resource or social, environmental, and economic outcomes.

Silvicultural prescription: The timing and sequence of silvicultural activities required to attain or sustain objectives over the course of an entire rotation.

Silvicultural regime: the specific sequence of activities defined in the silvicultural prescription.

Silvicultural system: A grouping of similar silvicultural prescriptions or regimes, usually based on similarity of treatments or objectives. Historically, silvicultural systems were grouped and labeled as "even-aged" or "uneven-aged" based on the number of age classes or regeneration methods (SAF 2013).

Special forest products: Items that can be harvested from forests but do not fall in traditional timber or fiber categories, such as Christmas trees and boughs, medicinal plants, and floral greens.

Stand development stage: A developmental phase of a forest, defined using a classification system based on the structural conditions and developmental processes occurring within a forest stand.

Stand replacement harvest: *see* regeneration harvest.

State Environmental Policy Act: A state law that provides a process for reviewing proposals that require permits or other forms of agency approval. It requires government agencies to consider the potential environmental consequences of their actions and incorporate

environmental values into their decision-making processes. It also involves the public and provides the agency decision-maker with supplemental authority to mitigate identified impacts.

State-of-the-forest file: An output of the tactical model. A forecast of forest conditions that are projected to occur as a result of implementing the tactical model's harvest schedule.

State trust lands: DNR-managed lands held as a fiduciary trust and managed to benefit specific trust beneficiaries (for example, public K–12 schools and universities, capitol buildings, counties, and local services such as libraries).

Stream type: On state trust lands in western Washington, DNR State Lands uses a numerical system (one through five) to categorize streams based on their physical characteristics such as stream width, steepness, and whether or not fish are present. Type 1 streams are the largest, Type 5 streams are the smallest. DNR and the Federal Services (NOAA Fisheries and USFWS) have agreed that the Washington Forest Practices Board Emergency Rules (stream typing), November 1996 meet the intent of DNR's HCP. Following are the emergency rules.

> **"Type 1 Water"** means all waters, within their ordinary high-water mark, inventoried as "shorelines of the state" under Chapter 90.58 RCW and the rules promulgated pursuant to Chapter 90.58 RCW, but not including those waters' associated wetlands as defined in Chapter 90.58 RCW.
>
> **"Type 2 Water"** shall mean segments of natural waters that are not classified as Type 1 Water and have a high fish, wildlife, or human use. These are segments of natural waters and periodically inundated areas of their associated wetlands, which:
>
> a. Are diverted for domestic use by more than 100 residential or camping units or by a public accommodation facility licensed to serve more than 100 persons, where such diversion is determined by the Department to be a valid appropriation of water and the only practical water source for such users. Such waters shall be considered to be Type 2 Water upstream from the point of such diversion for 1,500 feet or until the drainage area is reduced by 50 percent, whichever is less;
>
> b. Are diverted for use by federal, state, tribal or private fish hatcheries. Such waters shall be considered Type 2 Water upstream from the point of diversion for 1,500 feet including tributaries if highly significant for protection of downstream water quality. The Department may allow additional harvest beyond the requirements of Type 2 Water designation,

provided the Department determines after a landowner-requested on-site assessment by the Department of Fish and Wildlife, Department of Ecology, the affected tribes, and the interested parties that:

(i) The management practices proposed by the landowner will adequately protect water quality for the fish hatchery; and

(ii) Such additional harvest meets the requirements of the water type designation that would apply in the absence of the hatchery;

c. Are within a federal, state, local, or private campground having more than 30 camping units: *Provided* that the water shall not be considered to enter a campground until it reaches the boundary of the park lands available for public use and comes within 100 feet of a camping unit, trail or other park improvement;

d. Are used by substantial numbers of anadromous or resident game fish for spawning, rearing or migration. Waters having the following characteristics are presumed to have highly significant fish populations:

(i) Stream segments having a defined channel 20 feet or greater in width between the ordinary high-water marks and having a gradient of less than 4 percent.

(ii) Lakes, ponds, or impoundments having a surface area of 1 acre or greater at seasonal low water.

e. Are used by salmonids for off-channel habitat. These areas are critical to the maintenance of optimum survival of juvenile salmonids. This habitat shall be identified based on the following criteria:

(i) The site must be connected to a stream bearing salmonids and accessible during some period of the year; and

(ii) The off-channel water must be accessible to juvenile salmonids through a drainage with less than a 5% gradient.

"Type 3 Water" shall mean segments of natural waters that are not classified as Type 1 or 2 Water and have a moderate to slight fish,

wildlife, and human use. These are segments of natural waters and periodically inundated areas of their associated wetlands which:

a. Are diverted for domestic use by more than 10 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons, which such diversion is determined by the Department to be a valid appropriation of water and the only practical water source for such users. Such waters shall be considered to be Type 3 Water upstream from the point of diversion for 1,500 feet or until the drainage area is reduced by 50 percent, whichever is less;

b. Are used by significant numbers of anadromous or resident game fish for spawning, rearing or migration. If fish use has not been determined:

(i) Waters having the following characteristics are presumed to have significant anadromous or resident game fish use:

(A) Stream segments having a defined channel of 2 feet or greater in width between the ordinary high-water marks in western Washington and having a gradient 16 percent or less;

(B) Stream segments having a defined channel of 2 feet or greater in width between the ordinary high-water marks in Western Washington and having a gradient greater than 16 percent and less than or equal to 20 percent; and having greater than 50 acres in contributing basin size in western Washington;

(ii) The Department shall waive or modify the characteristics in (i) above where:

(A) Waters are confirmed, long-term, naturally occurring water quality parameters incapable of supporting anadromous or resident game fish;

(B) Snowmelt streams have short flow cycles that do not support successful life history phases of anadromous or resident game fish. These streams typically have no flow

in the winter months and discontinue flow by June 1; or

(C) Sufficient information about a geographic region is available to support a departure from the characteristics in (i), as determined in consultation with the Department of Fish and Wildlife, Department of Ecology, affected tribes, and interested parties.

(iii) Ponds or impoundments having a surface area of less than 1 acre at seasonal low water and having an outlet to an anadromous fish stream.

(iv) For resident game fish ponds or impoundments having a surface are greater than 0.5 acre at seasonal low water.

c. Are highly significant for protection of downstream water quality. Tributaries which contribute greater than 20 percent of the flow to a Type 1 or 2 Water are presumed to be significant for 1,500 feet from their confluence with the Type 1 or 2 Water or until their drainage area is less than 50 percent of their drainage area at the point of confluence, whichever is less.

"Type 4 Water" classification shall be applied to segments of natural waters which are not classified as Type 1, 2 or 3, and for the purpose of protecting water quality downstream are classified as Type 4 Water upstream until the channel width becomes less than 2 feet in width between the ordinary high-water marks. Their significance lies in their influence on water quality downstream in Type 1, 2, and 3 Waters. These may be perennial or intermittent.

"Type 5 Water" classification shall be applied to all natural waters not classified as Type 1, 2, 3, or 4; including streams with or without well-defined channels, areas of perennial or intermittent seepage, ponds, natural sinks and drainage ways having short periods of spring or storm runoff.

T

Tactical model: The forest estate model that DNR uses for harvest scheduling and other tasks.

Tail hold: A stump or tree which is used to support a block through which a cable runs back to a yarder (a machine used to move logs to a landing).

Trust: a relationship in which a person (or entity), the trustee, holds title to property that must be kept or used for the benefit of another, the beneficiary. According to the *Policy for Sustainable Forests*, a trust includes a grantor (the entity establishing the trust, such as the federal government), a trustee (the entity holding the title), one or more trust beneficiaries (entities receiving the benefits from the assets), and trust assets (the property kept or used for the benefit of the beneficiaries) (DNR 2006 p. 14). Washington State is the trustee of state trust lands and DNR is the trust land manager.

U

Uncertainty: Based on common usage, not knowing whether a proposition is true or false. It may refer to a current state or future outcome. In natural resource management, the main types of uncertainties are regarding the structure and functioning of an ecosystem and the management effects, including ecological, economic and operational feasibility outcomes. In this forest land plan, the following terms are used interchangeably: uncertainty, incomplete information, and limited knowledge.

V

Validation monitoring: For the *State Trust Lands Habitat Conservation Plan*, a data-collection system that determines whether or not certain species respond as expected to habitat conditions created by following a management plan and its strategies.

Variable density thinning: A type of commercial thinning in which a mixture of small openings (gaps), un-thinned patches (skips), and varying stand densities are created to achieve specific objectives, such as accelerating development of complex stand structure.

Variable retention harvest: a type of regeneration, or stand-replacement harvest in which elements of the existing stand, such as down wood, snags, and leave trees (trees that are not harvested), are left

for incorporation into the new stand. Variable retention harvest is different from a clearcut, in which all of the existing stand is removed.

Vision: A desired outcome based on an organization's values. *See* **goal**.

W

Windthrow: Blowing over or breaking of trees in the wind.

X-Z

Yarding: Transporting logs from where they are harvested to a landing.

Yarding corridor: The route used for yarding logs from where they are harvested to a landing.

Young Forest Habitat: Forests that meet the structural definition of sub-mature and young forest marginal habitat. Young Forest Habitat supports dispersal and provides some opportunities for roosting and foraging.

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