Appendix A

Draft OESF Forest Land Plan

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Acronyms

dbh	Diameter at breast height
DNR	Washington Department of Natural Resources
EIS	Environmental impact statement
FEIS	Final environmental impact statement
FEMAT	Forest Ecosystem Management Assessment Team
FMU	Forest Management Unit
FRIS	Forest resources inventory system
FVS	Forest Vegetation Simulator
GIS	Geographic information system
HCP	Habitat Conservation Plan
MMBF	Millions of board feet
NMFS	National Marine Fisheries Service
NPS	National Park Service
OESF	Olympic Experimental State Forest
PSF	Policy for Sustainable Forests
P&T	Planning and tracking database
RCW	Revised code of Washington
RDEIS	Revised draft environmental impact statement
SDI	Stand density index
SEPA	State Environmental Policy Act
USDA	United States Department of Agriculture
USDOI	United States Department of the Interior
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

Preface

This draft plan is based on the Landscape Alternative analyzed in the Olympic Experimental State Forest (OESF) Revised Draft Environmental Impact Statement (RDEIS). Washington Department of Natural Resources (DNR) is providing this draft to a) help readers understand what a forest land plan is; b) understand the types of information that may be included in a forest land plan, c) provide readers a chance to comment, and d) demonstrate how DNR may manage the OESF *if* the Landscape Alternative is chosen. **This plan is a work in progress. It is not intended as a final document, and will not guide management at this time.**

After the comment period for the RDEIS, DNR will prepare a final EIS (FEIS). Once the FEIS is published, DNR's decision maker (the Deputy Supervisor of Uplands) will select a final alternative. To make this decision, the Deputy Supervisor of Uplands will consider the potential environmental impacts of the alternatives; the ability of the alternatives to meet DNR's purpose, need, and objectives as described in the FEIS; and potential financial impacts of the alternatives on the trusts. The decision will be made with input from DNR staff and consultation with the Commissioner of Public Lands. While the final selected alternative may not be identical to any one alternative presented in the FEIS, it will be within the range analyzed. For example, elements of one alternative may be incorporated into another.

The final forest land plan will be based on the final selected alternative. **DNR cannot prepare a final forest land plan until a final alternative is selected from the FEIS.**

As part of developing this draft plan, DNR drafted updates of its northern spotted owl, riparian, and wetland procedures, and also drafted new procedures for conducting adaptive management and for response to natural disturbance events such as wind or fire. Like the forest land plan itself, **these new and updated procedures are drafts, and will not be finalized or take effect** until DNR has adopted the final forest land plan.

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Chapter 1

Background

In this chapter of the draft forest land plan, DNR provides an overview of this forest land plan, information on the analysis area, and a discussion about the history and management of the OESF.

Introduction

What Is a Forest Land Plan?

A forest land plan is a document that defines, for a given planning area such as the OESF, *what* DNR wishes to achieve and *how* it will achieve it. Forest land plans are often undertaken to balance multiple objectives such as revenue production and ecological values.

Forest land plans do *not* include site-specific designs for individual management activities such as building a segment of road or harvesting a certain stand of timber. Those activities are designed at a later stage of planning, as will be explained later in this chapter.

This draft forest land plan contains the following information:

- Basic information about the location and size of the OESF and an overview of state trust lands (Chapter 1).
- A discussion on DNR's management approach for state trust lands in the OESF. To provide context, DNR also provides a brief history of the OESF from its founding to the present day (Chapter 1).
- Goals and measurable objectives for state trust lands in the OESF (Chapter 2). These goals and measurable objectives are based on existing policies including the 2006 *Policy for Sustainable Forests* (PSF) and the 1997 *Habitat Conservation Pl*an (HCP).[1]
- The management strategies and the silvicultural system and regimes DNR will use to achieve its goals and measurable objectives for state trust lands in the OESF (management strategies, Chapter 2; silviculture, Chapter 3).

- Information on the forest estate model, including how it will be used to plan and implement management activities and how it will be updated over time as new information is gathered (Chapter 3).
- Description of adaptive management and how it will be conducted in the OESF using information from monitoring, research, and operations. DNR also lists priority research and monitoring activities to be implemented in the near term (Chapter 4).

The intended audience for this forest land plan is DNR foresters, managers, and scientists.

Why Does DNR Need to Develop a Forest Land Plan?

DNR needs to develop a forest land plan to meet the policy direction in the 1997 HCP and the 2006 PSF.

- Authorized under the Endangered Species Act (16 U.S.C. 1531 et seq.), the 1997 HCP is a long-term (at least 70 years) management plan to maintain and improve habitat for threatened and endangered species as well as unlisted native species on state trust lands within the range of the northern spotted owl. It states that "DNR expects landscape planning to be part of the process for implementing conservation strategies" in each HCP planning unit, including the OESF (DNR 1997, p. IV.192).
- The 2006 PSF guides DNR's management and stewardship of 2.1 million acres of forested state trust lands. It states that "In implementing Board of Natural Resources policy, the department will develop forest land plans at geographic scales similar to DNR's [1997] HCP planning units" (DNR 2006, p. 45).

To assist the reader, DNR provides brief definitions of key management terms used in this forest land plan (refer to Text Box A-1).

Text Box A-1. Definitions of Key Management Terms Used in this Plan

Vision

In the context of this forest land plan, a vision is a desired outcome. Visions are based on what is important to an organization; in other words, its values.

Mission

A mission is a statement of purpose. Like visions, missions are based on an organization's values.

Goals

Because visions are very broad, DNR breaks them down into goals. Goals are aspirational in nature and are worded generally to achieve broad aims. Goals:

- Are based on high-level policies (such as the 1997 HCP and 2006 PSF) and apply to the entire planning area,
- Are often qualitative and not directly measurable, and
- Are open-ended, meaning they have no time specified for their achievement.

An example of a goal is to "maintain and aid restoration of the physical integrity of stream channels and floodplains."

Text Box A-1, Continued. Definitions of Key Management Terms Used in this Plan

Measurable Objectives

Goals must be further broken down into objectives that can be measured, either indirectly or directly, to determine if they are being met. Measurable objectives:

- Describe end results;
- Are spatially specific, and may apply to all state trust lands in the OESF or to smaller areas such as landscapes or watersheds;
- Often have time specified for their achievement, and can be short term or long term (in this plan, if a time is not specified, the measurable objective applies until it is cancelled or replaced); and
- Are used as a basis for evaluating whether or not DNR is meeting its goals for state trust lands in the OESF.

An example of a measurable objective is "Increase the potential of the riparian forest to provide shade to the stream."

Management Approach

A management approach is a broad framework for how to achieve a vision. Setting aside one area for revenue production and another for ecological values is one example of a management approach. Another example is integrated management.

Conservation Strategies

Conservation strategies describe how DNR will manage types of wildlife habitat, such as riparian or northern spotted owl habitat. DNR's conservation strategies are presented in the 1997 HCP. Conservation strategies include objectives as well as direction on how to meet those objectives. For this forest land plan, DNR translated the objectives of the conservation strategies into *measurable* objectives, and general guidelines for meeting those objectives into *management strategies*.

Management Strategies

Management strategies specify the steps DNR will take to implement each component of a conservation strategy or other policy. Put another way, management strategies specify how DNR will meet each measurable objective. Management strategies:

- Guide activities;
- Apply to the entire planning area or to smaller areas such as landscapes or watersheds;
- Potentially aid the achievement of more than one measurable objective; and
- Potentially support the attainment of goals that have not been broken down into measurable objectives.

Procedure

Procedures are instructions for foresters completing tasks in the field. For example, a procedure may describe how to identify balds or talus slopes and how to conduct management activities around them. Procedures are often written to implement management strategies.

DNR's Decision Space: Forest Land Plans and DNR policies

DNR's decision space for this forest land plan is limited to the scope of current DNR policies. Put another way, DNR prepares forest land plans to determine the best way to implement current DNR policies rather than change them. To understand why, it is important to understand DNR's overall planning process.

DNR's planning process has three stages. These stages are strategic, tactical, and operational (refer to Figure A-1).

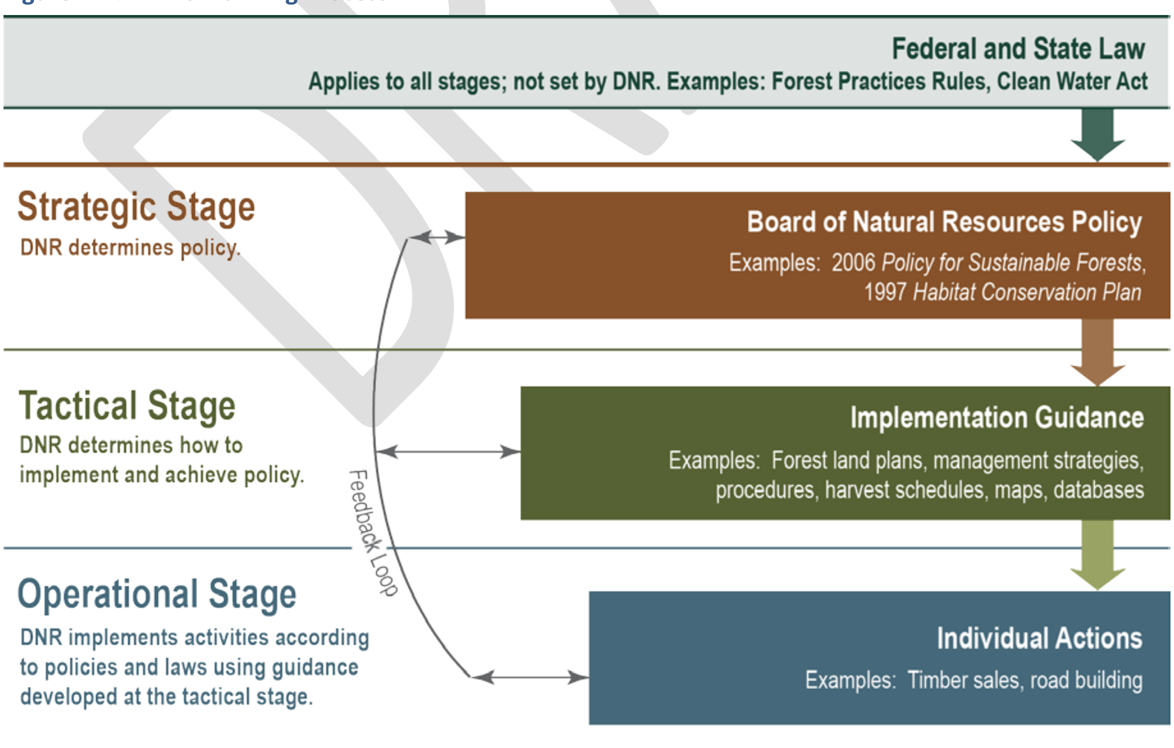
- At the **strategic stage** of planning, DNR writes policies. Policies define DNR's basic operating philosophy, set standards and objectives, and provide direction upon which subsequent decisions can be based. All policies are written in the context of local, state, and federal laws, and are approved and adopted by the Board of Natural Resources.

- At the **tactical stage**, DNR determines *how* it will implement and achieve policies developed at the strategic stage. At this stage of planning, DNR develops forest land plans, management strategies, procedures, maps, models, databases, and other guidance.

  DNR does not develop policies at this stage. However, the planning process includes a feedback loop. Information gathered to develop and implement forest land plans may be used to inform future policy decisions.

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

Figure A-1. DNR's Planning Process



State Environmental Policy Act (SEPA) review occurs at each stage of planning. Policies are evaluated at the strategic phase, forest land plans are reviewed at the tactical stage, and site-specific projects or actions, such as an individual timber sale, are evaluated at the operational stage, if required, as they are proposed.[2] Therefore this forest land plan is part of a phased review under WAC 197-11-060 (5)(c)(i).

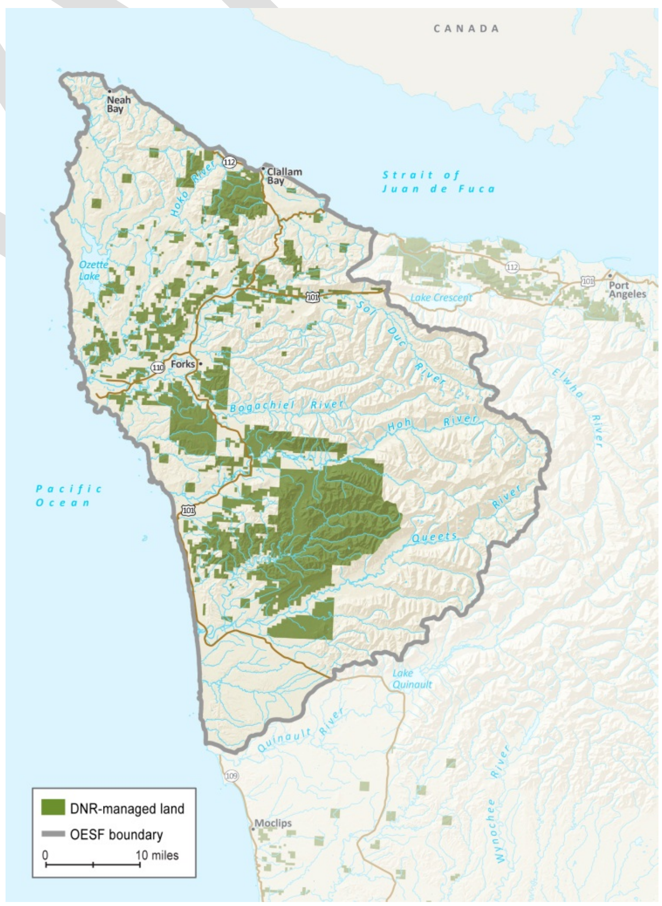
Not all activities completed in the operational phase require SEPA review. For example, pre-commercial thinning[3] and tree planting are Class I Forest Practices[4] and so are categorically exempt from SEPA review, as described in RCW 43.21C.037.

What If DNR Policies Change During Plan Implementation?

DNR recognizes that economic, social, political, and cultural changes over time may result in a change in DNR policies or state or federal laws. DNR may also update its policies as a result of new scientific information. Changes in policy or laws may require an update or amendment to the draft forest land plan.

Two DNR policies currently being developed in separate planning processes are the **long-term Marbled Murrelet Conservation Strategy** and the next **sustainable harvest calculation**. The long-term Marbled Murrelet Conservation Strategy will help conserve marbled murrelet habitat while allowing DNR to conduct timber harvest and other activities. The sustainable harvest calculation sets the next sustainable harvest level, or the volume of timber scheduled to be offered for sale from state trust lands during a planning decade. Since the OESF is a separate sustainable harvest unit, it will be assigned its own level. These policies are being developed in separate planning processes and both will undergo environmental analysis and public review as part of those processes. Adoption of these policies may lead to an amendment of the forest land plan.

Map A-1. OESF Vicinity Map



Planning Area

Where Is the OESF?

The OESF is located in western Clallam and Jefferson counties on the Olympic Peninsula. It 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. The OESF is mostly forested and ranges in elevation from 0 to 7,952 feet (refer to Map A-1).

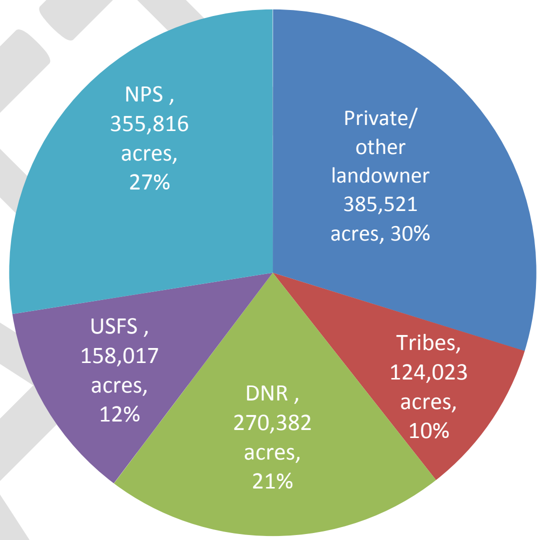
How Was the OESF Delineated?

The OESF is one of nine habitat conservation planning units identified in DNR's 1997 HCP. The OESF was delineated by combining all or part of three water resource inventory areas: water resource inventory area No. 20 (Soleduck/Hoh) in its entirety and a portion of water resource inventory areas 19 (Lyre/Hoko) and 21 (Queets/Quinault). Water resource inventory areas are established by the Washington Department of Ecology (Ecology) and other state natural resources agencies for planning and management of the state's major watersheds.

How Much of the OESF Does DNR Manage?

The OESF boundaries encompass lands managed by DNR as well as the United States Forest Service (USFS), National Park Service (NPS), private landowners (including timber companies), tribes, and others. DNR manages 21 percent, or 270,382 acres, of the approximately 1.3 million acres of the OESF (refer to Chart A-1). That total includes 3,008 acres of natural resource conservation areas, 504 acres of natural area preserves,[5] and 266,870 acres of state trust lands (refer to "What are State Trust Lands?" later in this chapter). In this forest land plan, the term "OESF" refers to the entire planning area, including lands owned and managed by other landowners.

Chart A-1. Land Ownership in the OESF



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. Acres of DNR-managed lands within each landscape range from approximately 8,500 to over 50,000 acres (refer to Table A-1). Totals in Table A-1 exclude acres of non-forested areas such as administrative sites, roads, and water bodies, but include natural area preserves and natural resources conservation areas. A physical description for each of the 11 landscapes within the OESF planning unit is provided in Chapter 3.

Table A-1. Acres of State Trust Lands in the OESF, by Landscape[a]

Landscapes	Acres of State Trust Lands
Clallam	17,276
Clearwater	55,203
Coppermine	19,246
Dickodochtedar	28,047
Goodman	23,799
Kalaloch	18,122
Queets	20,807
Reade Hill	8,479
Sekiu	10,014
Sol Duc	19,146
Willy Huel	37,428
TOTAL	257,566

[a]Excludes non-forested areas but includes natural area preserves and natural resource conservation areas.

Will the OESF Forest Land Plan Apply to Private, Federal, or Tribal Lands?

No, **DNR's forest land plan will apply *only* to the management of state trust lands located within the OESF boundaries.**

What Are State Trust Lands?

In this forest land plan, the term "state trust lands" refers to both State lands and State forest lands in the OESF.

- **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.

State trust lands are held as fiduciary trusts to provide revenue to specific trust beneficiaries. Of the current 5 million acres of state trust lands statewide, roughly 2 million are forested and 1 million are in agricultural production. The remaining 2 million acres are aquatic lands.

What Is a Trust?

State trust lands generate revenue for schools, universities, and other public institutions

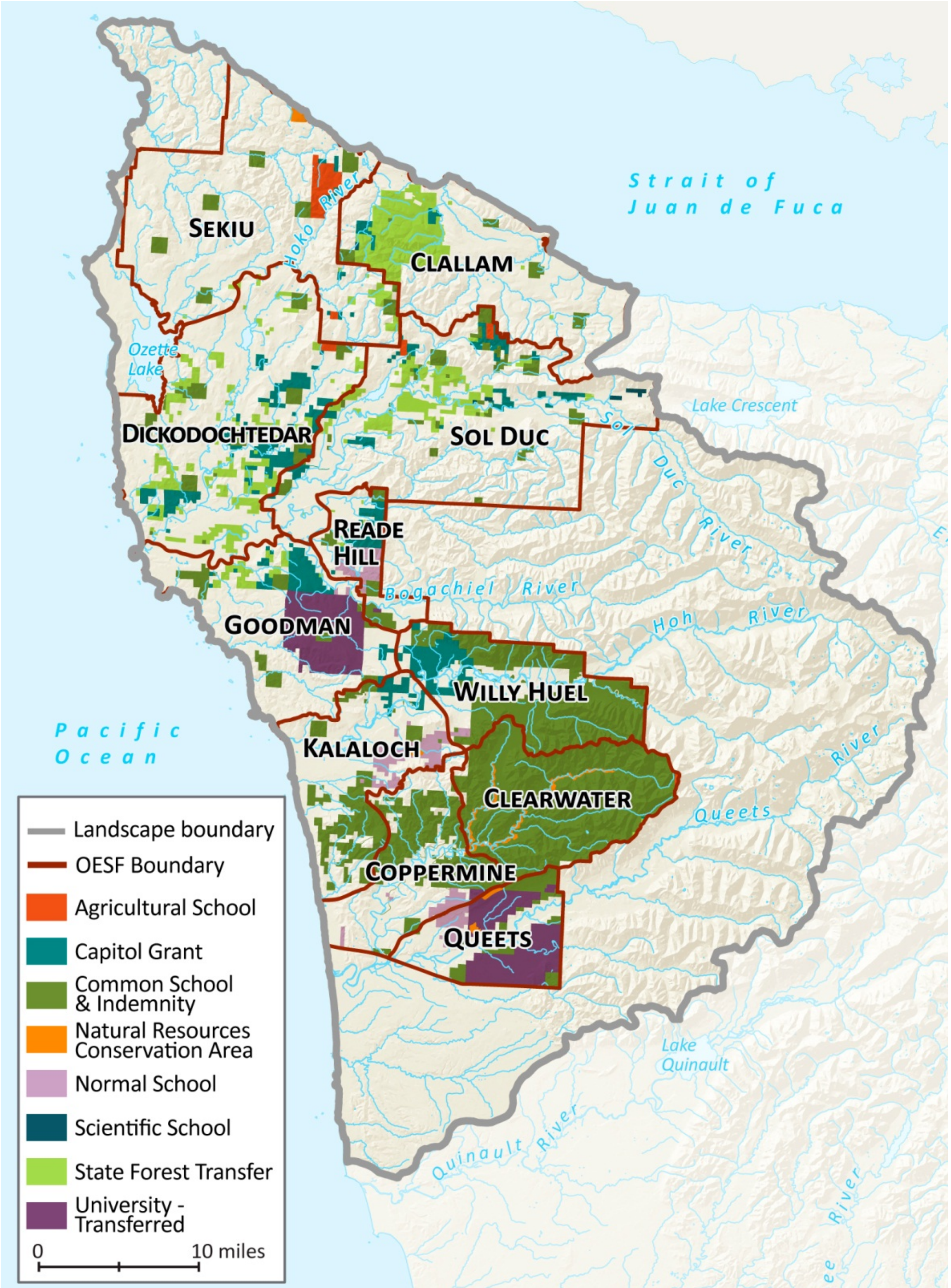
A trust is a relationship in which a person (or entity), the trustee, holds title to property that must be kept or used for the benefit of another, the beneficiary. According to the 2006 PSF, a trust includes a grantor (the entity establishing the trust, such as the federal government), a trustee (the 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). 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, commonly referred to as the trust mandate. 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 2004). 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 2006 PSF, pages 9 through 16, for a complete description of DNR's trust management duties.[6]

DNR provides revenue to its trust beneficiaries through leases, permits, fees, and other means. On state trust lands in the OESF, the primary means of generating revenue is the harvest and sale of timber. The current (2004-2014) sustainable harvest level for the OESF is 576 million board feet for the decade, as approved by the Board of Natural Resources in 2007.[7]

Map A-2[8] shows the location of state trust lands within each landscape in the OESF. Table A-2 provides the acres of state trust lands in each trust, by landscape.

Map A-2. State Trust Lands Within Each Landscape[a]



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

Table A-2. State Trust Lands by Trust and Landscape[a]

	Clallam	Clearwater	Coppermine	Dickodochtedar	Goodman	Kalaloch	Queets	Reade Hill	Sekiu	Sol Duc	Willy Huel	TOTAL
Agricultural-School	0	157	0	313	0	0	0	0	3,042	561	0	4,073
Capitol Grant	976	105	0	8,307	4,406	1,580	0	3,213	736	4,345	5,378	29,046
Common-School-and-Indemnity	1,975	52,591	17,215	5,717	3,899	11,744	4,742	1504	4,293	5,226	31,774	140,680
Escheat	0	0	0	0	0	10	0	0	0	0	0	10
Normal-School	0	0	1,651	0	119	4,512	1,973	3,447	0	0	326	12,028
Scientific-School	82	0	0	0	0	0	0	0	0	468	0	550
State-Forest-Purchase	0	0	0	4	0	0	0	0	0	0	0	4
State-Forest-Transfer	14,264	159	0	13,697	2,018	0	0	224	1,645	8,539	0	40,546
University Original	0	0	0	0	0	0	208	0	0	0	0	208
University Transferred	0	0	432	0	13,403	0	13,374	80	0	0	0	27,289
TOTAL	17,297	53,012	19,298	28,038	23,845	17,846	20,297	8,468	9,716	19,139	37,478	254,434

[a]Excludes natural area preserves, natural resources conservation areas, and non-forested areas

History of the OESF

To understand the OESF and how it will be managed in the future, it is essential to understand its past. In the following section, DNR describe the history of the OESF from its founding to the present day.

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

Prior to the late 1980s, DNR had a policy to harvest the oldest timber first (DNR 1979). The intent of this policy was to replace mature and old-growth stands with younger, faster-growing forest stands that would provide greater long-term financial benefits to the trusts.

Under this policy, 1988 harvest projections indicated that most of the remaining mature and old-growth forests (approximately 60,000 acres) on state trust lands on the western Olympic Peninsula would be harvested within 15 years. Harvest levels would then drop steeply for several decades until sufficient second growth was available to support higher harvest levels around 2030 (Commission on Old Growth Alternatives for Washington's Forest Trust Lands 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 on Old Growth Alternatives for Washington's Forest Trust Lands (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 (16 U.S.C. 1531 et seq.); [9] 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. The OESF was envisioned as a place to explore the relationship between management activities and ecological values and experiment with silvicultural techniques:

> "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 on Old Growth Alternatives for Washington's Forest Trust Lands 1989).

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. This time period would allow DNR to learn from management and research. At the end of 15 years, DNR would make a decision on how to manage remaining stands of mature forest. [10] 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 later transferred out of state trust land status and designated as natural area preserves and natural resource conservation areas (refer to Table A-3).

The Commission also recommended designating the OESF an independent sustainable harvest unit. As an independent unit, state trust lands in the OESF would not be subject to the requirements of the state-wide sustainable harvest level, but would be assigned its own sustainable harvest level. The intent was to stabilize the supply of wood to the local economy and slow (but not stop) the loss of Old-growth forest on state trust lands.

Table A-3. Natural Resource Conservation Areas and Natural Areas Preserves in the OESF

Name	Acres	Features
South Nolan Natural Resource Conservation Area	213	Old-growth coastal forest, forested sphagnum bog, and low elevation sphagnum bog
Clearwater Corridor Natural Resource Conservation Area	2,323	Mature coastal forest, aquatic-riparian habitat
Shipwreck Point Natural Resource Conservation Area	472	Puget Sound beach, stream and riparian habitat and coastal forest
Clearwater Bogs Natural Area Preserve	504	Forested sphagnum bog, low elevation sphagnum bog
TOTAL ACRES	**3512**	

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).

Preliminary Planning: the 1991 Draft OESF Forest Management Plan

DNR carried the intent 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 not adopted, finalized, or published, 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 A-2).

Per the 1991 Plan, management of state trust lands in the OESF would focus on meeting goals and objectives for revenue production and

Text Box A-2. Categories of 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 bodies. Riparian areas are the areas where aquatic and terrestrial ecosystems interact (such as wetlands and riparian forests).
- **Biological diversity**: The full range of life in all its forms (Washington Biodiversity Council).
- **Ecosystem resilience**: Ability of an ecosystem to recover from disturbance.

ecological values across the *same* lands, rather than designating some areas strictly for revenue and others for ecological values. This approach, which today is 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 structural complexity 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 within managed forest stands and across state trust lands, DNR could meet most of the habitat needs of native plant and wildlife species (DNR 1991). Examples of structural complexity 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 the OESF would be a mix of managed stands and old-growth stands, including those on 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, which was finalized. DNR’s Olympic Region staff also developed preliminary (not finalized) 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.

Listing of Threatened Species and the 1997 HCP

In 1990, the United States Fish and Wildlife Service (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 A-3).

Text Box A-3. 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 follow the lead of federal agencies and 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 will take to offset any harm of individual members of a listed species by promoting the conservation of the species as a whole.

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.

Similar to the 1991 Plan, the 1997 HCP stipulated that DNR would continue integrating revenue production and ecological values across state trust lands. The intent, as before, was to "have a forest that includes a full range of forest conditions in order to ensure that trust revenues are produced, quality timber is available for harvest, and native species have sufficient habitat." Also similar was the HCP's approach to integrated management, with emphasis on research and monitoring, adaptive management, and silviculture as an integration tool (refer to "The OESF: Looking Forward" later in this chapter).

One of the primary differences between the two plans, however, was the 1997 HCP's approach to habitat conservation. The 1991 Plan emphasized a non-species specific approach of managing for structural complexity within and across forest stands. The 1997 HCP introduced habitat conservation strategies aimed at specific species of wildlife. This was done to meet the requirements of the Endangered Species Act.

The 1997 HCP contains a northern spotted owl conservation strategy, a riparian conservation strategy that focuses on the needs of salmonid species and other non-listed and candidate species dependent on in-stream and riparian environments, and a multi-species conservation strategy that considers the needs of wildlife species of concern and other unlisted species in the OESF (the HCP did not include a long-term habitat conservation strategy for marbled murrelets because DNR lacked sufficient scientific data to develop one at that time). These strategies were designed to be inter-dependent. For example, the riparian conservation strategy was designed to produce 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). DNR also believed that the aggregate, landscape-level effects of implementing the riparian conservation strategy, in concert with habitat conservation measures for marbled murrelets and northern spotted owls, would result in habitat for most unlisted wildlife species (DNR 1997 p.137).

Each habitat conservation strategy was designed to provide DNR with the operational flexibility it would need to continue integrating revenue production and ecological values across state trust lands. For example, under the northern spotted owl conservation strategy, DNR would not designate specific management areas within the OESF boundaries for northern spotted owl habitat, as DNR does in other HCP planning units. Instead, DNR would restore, then maintain minimum thresholds of habitat on state trust lands within each landscape: 40 percent Young Forest Habitat or better (Young Forest or Old Forest), at least half of which (20 percent) is Old Forest Habitat. This approach is unique from other DNR HCP planning units in which DNR designates specific areas as northern spotted owl nesting, roosting, foraging, and dispersal habitat (refer to Chapter 2 for more information on habitat types and the northern spotted owl conservation strategy). The 1997 HCP referred to this approach to northern spotted owl habitat conservation as the “unzoned” approach (today, DNR uses the term “integrated management;” refer to “The OESF: Looking Forward” later in this chapter).

While the habitat conservation strategies in the 1997 HCP gave DNR greater management certainty in the face of the Endangered Species Act, they also provided greater uncertainty in outcomes for both revenue production and ecological values. DNR agreed, as part of the 1997 HCP, to address these uncertainties through a research and monitoring program, and to systematically apply the knowledge gained through an adaptive management process.

Biodiversity Pathways and the Washington Forest Landscape Management Project

While DNR was developing landscape plans in the OESF in the late 1990s, it was also participating in parallel research efforts. 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 called the Washington Forest Landscape Management Project (Project). The Project’s charter was to research ways to meet the needs of wildlife associated with late-seral forests while minimizing impacts on revenue production in Washington’s forests (Carey and others 1996). The study area was the Clallam landscape in the OESF.

The Project developed a new approach to forestry called “biodiversity pathways.” Biodiversity pathways was designed to maximize biodiversity through 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 long rotations (70-130 years).

The Project developed six forest management scenarios, one of which was maximizing biodiversity through biodiversity pathways techniques. The Project set a goal of attaining at least 30 percent late-seral forest in the study area. 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 achieved the goal of late-seral forest more quickly than other management strategies and produced significant economic benefit (Carey and others 1996). These results were published in the report *Washington Forest Landscape Management Project – a Pragmatic, Ecological Approach to Small-Landscape Management* (Carey and others 1996).

In 2004, DNR incorporated biodiversity pathways techniques into the preferred alternative for the 2004-2014 sustainable harvest calculation Environmental Impact Statement (EIS). 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).

DNR selected the preferred alternative in 2004. In 2006, DNR finalized and incorporated the general silvicultural strategy into the 2006 PSF (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.

The OESF: Looking Forward

Going forward, DNR’s mission will be to intentionally learn how to integrate revenue production and ecological values across as much of state trust lands in the OESF as possible to meet DNR’s vision for the OESF (refer to Text Box A-4). DNR’s vision is a more productive, healthier, biologically diverse, and structurally complex forest that support native wildlife species and provide a perpetual source of revenue for public schools, universities, local hospitals, library districts, and other trust beneficiaries.

In the following section, DNR describes integrated management and how DNR proposes to implement it on state trust lands in the OESF. For more information on the habitat conservation strategies, refer to Chapter 2.

Text Box A-4. DNR's Mission and Vision for State Trust Lands in the OESF

DNR's Mission for State Trust Lands in the OESF

To intentionally learn how to integrate revenue production and ecological values across as much of state trust lands in the OESF as possible to meet DNR's vision for the OESF.

DNR's Vision for State Trust Lands in the OESF

A more productive, healthier, biologically diverse, and structurally complex forest that support native wildlife species and provide a perpetual source of revenue for public schools, universities, local hospitals, library districts, and other trust beneficiaries.

What Is Integrated Management?

Integrated management[11] is an approach to management based on the principal that a forested area can be managed to provide both revenue production and ecological values (such as biodiversity) across its width and breadth. The integrated management 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 or a commercial forest managed for revenue production.[12]

The intent behind integrated management is to actively manage as much of state trust lands as possible to provide revenue production and ecological values. Active management includes planting trees, managing vegetation, thinning forests, and performing stand-replacement harvests. Each of these "human-influenced disturbance" activities is designed to encourage the development, through natural growth processes, of conditions that support both revenue production and ecological values. For example, to support biodiversity, DNR uses harvest methods that promote structural complexity within and across forest stands. Examples of structural complexity include snags, down wood, multiple canopy layers, and forest openings.

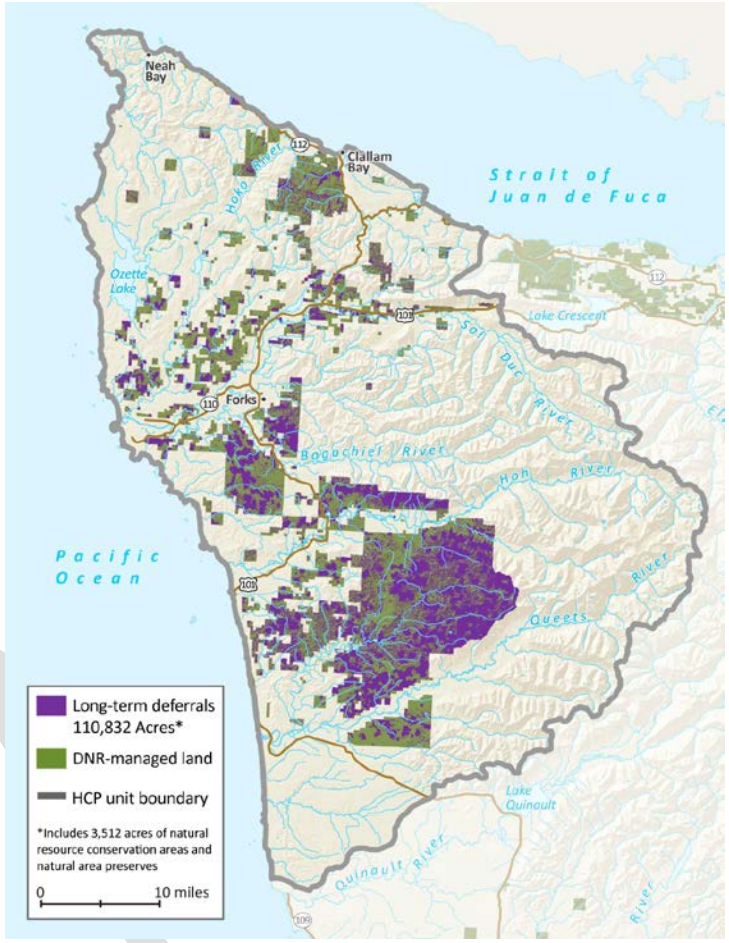
All Areas Do Not Contribute Equally

The integrated management approach does not imply that every acre of state trust lands in the OESF must contribute equally to both revenue production and ecological values; nor does it imply that all areas will be actively managed. Instead, DNR actively manages state trust lands in the OESF *to the maximum extent possible* (DNR 2006).

Some areas, due to their physical characteristics or their importance to ecological values (or both), provide limited support for revenue production. For example, riparian management zones, which are designated along streams, are managed primarily for ecological values according to the riparian conservation strategy.

Other areas are *currently* deferred from harvest of timber, meaning they are not currently available or scheduled for harvest per current policy or other reasons (refer to "Deferrals May Change" later in this section). For example, some forest stands are deferred per the 2006 PSF; an example is old-growth stands.[13] In another example, potentially unstable slopes are currently deferred to reduce the risk of landslides. Deferrals currently account for 40 percent, or 107,320 acres of state trust lands in the OESF. An additional 3,512 acres in the OESF are designated permanently as natural area preserves and natural resource conservation areas, which are not considered state trust lands and cannot be harvested but which contribute to the objectives of DNR's conservation strategies. Together, these areas account for 43 percent of DNR-managed lands in OESF. The remaining 57 percent (146,734 acres) is considered operable, or available for harvest according to current policies and laws.

Map A-3. Harvest Deferrals on State Trust Lands in the OESF



What makes the integrated management approach unique is that deferrals, riparian management zones, and other areas managed primarily for ecological values are **interspersed with more actively managed areas, *not* consolidated in large blocks** (refer to Map A-3). These areas are meant to complement each other. The net result of deferring some areas, actively managing as many areas as possible, and implementing the habitat conservation strategies across state trust lands should be a structurally diverse, healthy forest ecosystem that provides both revenue production and ecological values.

Deferrals May Change

With the exception of natural area preserves and natural resource conservation areas, deferrals **may be released for harvest** in the future due to a change in policy, a change in forest conditions, new scientific information on the integration of revenue production and ecological values, or other factors. Should that occur DNR will do additional environmental analysis to assess the potential environmental impacts of harvesting these areas.

In addition, DNR may conduct limited management activities on deferrals as long as such activities are consistent with current DNR policy. For example, DNR may build short segments of roadway through a deferral. The potential environmental impact of these activities will be evaluated on a site-specific basis at the time they are proposed.

Projections in Chapter 3 of this plan are based on an assumption that areas currently deferred from harvest will remain deferred for the entire 100-year analysis period. It is not possible to predict when or if these areas will be released for harvest.

Management will Evolve

Integrated management is both a long-term vision and an experimental approach that is expected to evolve over time. As DNR implements integrated management, it will intentionally learn how to achieve integration more effectively. This emphasis on intentional learning makes the OESF unique. On state trust lands in the OESF, DNR has latitude and opportunity to experiment that is not granted to other habitat conservation planning units. Also, few experimental forests offer the opportunity to experiment and conduct research on commercial harvest techniques and their impact on ecological values on the spatial scale possible on state trust lands in the OESF.

In addition to operational experience, DNR will learn through **research and monitoring**. DNR performs research and monitors management activities to gather information about natural systems and how they are affected by management. The 1997 HCP requires three types of monitoring: implementation monitoring, used to determine whether 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 wildlife species these strategies are intended to benefit (DNR 1997 p. V.1).

Information gathered through operational experience, research, and monitoring will be applied to future management through **adaptive management**.[14] Changes proposed under adaptive management may range from small adjustments to DNR's procedures to recommendations for a change in policy. **Changes to policy, such as altering the objectives of a conservation strategy, would require approval by the Board of Natural Resources**; these changes may also require additional environmental analysis and an update to this draft forest land plan. Some changes may require consultation with the Federal Services (USFWS and NOAA Fisheries).

Changes to procedures and management strategies would not require Board of Natural Resources approval because they are not considered policy. Such changes are expected; in an experimental forest, management strategies and procedures are meant to be tested and altered as needed. **The flexibility to change management in response to new information is central to the concept of an experimental forest.**

DNR will examine any proposed change to its management of state trust lands in the OESF to determine if that change falls within the range of impacts analyzed for this forest land plan. If it does not, additional environmental analysis under SEPA may be required. For a full description of DNR's research and monitoring program and adaptive management process, refer to Chapter 4 of this plan.

How Will Integrated Management be Implemented?

To implement integrated management, the 1997 HCP recommends six management processes. These processes are planning from a landscape perspective, silviculture, research and monitoring, application of knowledge gained, effective information management, and effective communication.

Planning from a Landscape Perspective

One of the challenges of the integrated management approach is to a) understand the contribution different areas can make toward revenue and ecological values objectives across multiple spatial scales and across time, and b) balance management accordingly. Forests are never static. As they change through time through harvest, natural growth, or natural disturbances, their contribution to revenue production and ecological values changes also. Such changes must be factored into planning and management.

To meet these challenges, DNR uses "planning from a landscape perspective." Planning from a landscape perspective involves using computer models to understand how management actions taken today will affect the future condition of the forest and DNR's ability to meet multiple objectives over time.

The 1991 Draft OESF Management Plan recommended separate plans for each of the OESF's 11 landscapes. Today, better forest information and more powerful technology enables DNR to shift from writing individual landscape plans, to writing a single plan for all state trust lands in the OESF.

Planning at this level of complexity requires extensive data describing physical and biological characteristics and powerful, computer-based analytical tools. DNR uses several, but the tool most central to the forest land planning process is the forest estate model.

DNR'S FOREST ESTATE MODEL

DNR's forest estate model is a sophisticated, computer-based, mathematical representation of the forest. For this planning effort, DNR used the *Remsoft Spatial Planning System*, a commercially available forest estate modeling software package developed by Remsoft, Inc.

The model was developed with information on current conditions, objectives, management activities, and an understanding of natural growth processes and how forests respond to management activities. By simultaneously considering all of this information, the model develops an optimal solution of which forest stands to harvest (when, where, and by what harvest method) and which stands not to harvest across state trust lands over time to meet both revenue production and ecological values objectives as effectively and efficiently as possible. To make these decisions, the model considers numerous interrelated factors, such as when the stand will be mature enough to harvest, whether or not it is deferred from harvest, how it may contribute to the objectives of DNR's conservation strategies, and how it may contribute to revenue production. Refer to Appendix D for a full explanation of how the model works.

The model provides two major types of outputs. Both provide information for operational planning:

- A **harvest schedule.** The harvest schedule is the model's solution in list and map form. It projects the types, locations, and timings of harvests for the 100-year analysis period (reported in decade intervals). By consulting the harvest schedule, DNR foresters and managers can determine which harvest activities are projected for a given area in a given decade. For example, in one area the model may project a thinning in Decade 3 and a variable retention harvest in Decade 8. In others, the model may project a thinning in Decade 5, or no harvest in any decade because the stand is deferred from harvest.

- A **state of the forest file**. The state of the forest file is a forecast of forest conditions that are projected to occur as a result of implementing the harvest schedule. Foresters can use the state of the forest file to access information about the current condition of a forest stand, and how the condition of that stand may change based on a series of management activities. For example, if a forest stand is thinned in Decade 3, what condition will it be in by Decade 6? Will the forest stand have one canopy layer or two? Will it develop into northern spotted owl habitat? By comparing conditions at different, future points in time, DNR can evaluate whether planned management activities may enable DNR to meet its objectives: "Activities and the resulting landscape-level conditions can be projected and evaluated across space and time to ensure the forest condition is moving in the desired direction through a dynamic process" (DNR 1997, p. IV.83).

Why 100 Years?

DNR ran the model using a 100-year analysis period because this period is long enough to identify potential changes to the environment. **This does not imply that DNR planned 100 years of harvests**. Instead, DNR generated projections that will enable it to determine whether timber harvests planned today will enable DNR to meet its long-term objectives.

How Will the Model Outputs Be Used?

DNR will use the harvest schedule to guide the design and location of timber sales. **It is important to understand that timber sales may not be implemented on the ground exactly as they are modeled.** Although the forest estate model is a powerful tool that represents current knowledge and data about current conditions and forest ecosystems, it is essentially a mathematical representation or simplification of complex natural systems. It cannot replace the professional role and judgment of foresters working in the field.

Foresters will compare model results to on-the-ground conditions and make changes as necessary to accommodate unmapped streams, potentially unstable slopes, or other features. In addition, the model may select areas that are too small, difficult, or expensive to harvest; such areas may be left unharvested or combined with an adjacent harvest in a future decade. Similarly, foresters will combine model outputs with professional judgment and on-the-ground observation to write silvicultural prescriptions.

DNR will use the state of the forest file to evaluate how planned management activities may affect DNR's ability to meet its objectives. Refer to Chapter 3 for more information on how model outputs will be used in the OESF.

As the forest land plan is implemented, information gathered in the field or from other sources will be incorporated into the model to improve the model's accuracy and inform future management decisions. The model will be re-run periodically to reflect updated information and keep DNR on track to meet its objectives.

Silviculture

Silviculture is the art and science of managing forests to accomplish objectives. The practice of silviculture involves the establishing forests, controlling competing vegetation, and determining the composition, health, and quality of forests to meet the desired objectives. Silviculture is one of the primary tools that DNR will use to achieve integration of revenue production and ecological values. Through silviculture, DNR will promote structural complexity within managed forests. Structural complexity includes snags, down wood, multiple canopy layers, and forest openings. Structural complexity supports biodiversity (an ecological value).

Research and Monitoring

Integrated management is both a long-term vision and an experimental approach that is expected to evolve over time. As stated previously, DNR will intentionally learn how to achieve integration more effectively as integrated management is implemented. Such learning should lead to improved management with greater confidence in outcomes. In addition to operational experience, learning will come through research and monitoring.

The objectives of research and monitoring are as follows:

- Acquire new information that allows DNR to a) meet trust obligations through timber harvesting, b) conserve and protect public resources (wildlife, fish, water), and c) maintain the long-term health and productivity of the forest ecosystem.
- Monitor implementation of the 1997 HCP and evaluate the effectiveness of activities in meeting OESF objectives.
- Ensure that information-gathering activities are carried out in a scientifically credible manner, allowing confident use of results in management decisions.
- Ensure that information-gathering activities are well coordinated and that the results of different investigations are integrated to achieve OESF objectives.
- Ensure that new information is considered and incorporated into management as appropriate.

These objectives are based on the 1997 HCP, p. IV.82 through IV.83.

Research and monitoring will focus on both the research priorities of the 1997 HCP and key uncertainties identified during this forest land planning process. A list of key uncertainties and priority research and monitoring activities can be found in Chapter 4 of this plan.

Systematic Application of Knowledge Gained: Adaptive Management

As stated previously, information gathered through research and monitoring will be used to improve management of the OESF through an adaptive management process. The process has clearly defined steps, including identifying priority adaptive management questions and uncertainties, addressing those uncertainties through research and monitoring, evaluating and interpreting the information gathered, recommending changes in management (if appropriate), and going through a formal decision process to apply those changes to management (refer to Chapter 4). DNR has developed a draft adaptive management procedure which identifies DNR staff participating in the adaptive management process and their responsibilities (refer to Appendix A-3).

Efficient Information Management

Information management is the means by which information is collected, organized, analyzed and interpreted for the intended audience, and distributed for use in future decision making. Information management provides crucial links between operations, research and monitoring, and planning.

DNR will collect, organize, and store data in a way that makes it easy to access and exchange with external parties. This information falls in four broad categories: 1) records of land management activities such as timber harvests and road management; 2) research and monitoring information including study plans, data, reports, and publications; 3) spatial and non-spatial datasets that describe natural resources and ecological conditions; and 4) policies, plans, procedures, and guidelines. Refer to Information Management (Appendix A-1) for additional information.

Effective Communication

Effective communication will occur through HCP annual reports and reports of the OESF research and monitoring program. Communication may also occur through individual project reports, workshops, symposiums, publications, and informal presentations. Public outreach activities may include field tours with local schools and other interested parties. In addition, DNR also provides a large amount of information about the OESF on a website (http://www.dnr.wa.gov/ResearchScience/Topics/TrustLandsHCP/Pages/lm_hcp_oesf_main.aspx).

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[1] http://www.dnr.wa.gov/Publications/lm_psf_policy_sustainable_forests.pdf; http://www.dnr.wa.gov/Publications/lm_hcp_plan_1997.pdf

[2] Site-specific evaluations allow DNR to reconsider all information, make any relevant changes based on localized conditions, and consider possible mitigation, if appropriate.

[3] A precommercial thinning is done to concentrate growth on the more desirable trees. This type of thinning does not generate revenue; trees that are thinned are neither removed from the site nor sold.

[4] Operations that have been determined to have no direct potential for damaging a public resource (WAC 222-16-050).

[5] Natural resources conservation areas often include significant native ecosystems and geologic features, archaeological resources or scenic attributes. Natural area preserves protect the highest quality native ecosystems and generally host more sensitive or rare species.

[6] The 2006 PSF contains a succinct discussion of the trust mandate and common law duties of a trustee as interpreted by DNR and approved by the Board of Natural Resources.

[7] Any changes made to the sustainable harvest level must be approved by the Board of Natural Resources.

[8] Refer to State Trust Lands map (http://www.dnr.wa.gov/Publications/eng_rms_trustlands_map_nu2.pdf) for lands held in trust statewide to support specific public beneficiaries.

[9] 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.

[10] These acres are still deferred today per conservation objectives for the northern spotted owl and current policies such as the policy on Old-Growth stands in Western Washington in the 2006 PSF.

[11] Instead of “integrated management,” the 1997 HCP used the term “unzoned” to describe how the OESF will be managed. In a completely unzoned forest, no areas are deferred from harvest; harvests can be scheduled anywhere. However, a completely unzoned OESF is not possible, because the OESF has fixed geographic features that require special management consideration. Examples include riparian areas, wetlands, unstable slopes, talus fields, and other features. Due to their physical characteristics, sensitivity, or importance to ecological values, such areas may provide only limited support for revenue production. Other areas are deferred from harvest under current DNR policy; an example is old-growth forests. Therefore DNR feels that “integrated management” is a more accurate and descriptive term for DNR’s management approach in the OESF.

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[12] Integrated management is often referred to as land sharing in scientific literature.
[13] Mature, structurally complex stands of five acres and larger that originated naturally before the year 1850
[14] Adaptive management is referred to in the 1997 HCP as "Systematic Application of Knowledge Gained" (DNR 1997 p. IV.84).

Chapter 2

Management Goals, Measurable Objectives, and Strategies

In this chapter of the draft forest land plan, DNR describes specific goals, measurable objectives, and strategies for the integrated management of state trust lands in the OESF. This chapter is organized into three sections: revenue production, ecological values, and research, monitoring, and adaptive management.

Revenue Production

Introduction

As explained in Chapter 1, state trust lands are held as fiduciary trusts to provide revenue, in perpetuity, to specific trust beneficiaries such as schools and universities (DNR 2006, p. 14-16). In the following section, DNR describes its goals, measurable objectives, and strategies for revenue production from state trust lands in the OESF.

Goal

Produce revenue for trust beneficiaries through the harvest and sale of forest products, primarily timber.

Measurable Objective

Harvest and sell a volume of timber that is consistent with the current sustainable harvest level for the OESF. The current sustainable harvest level is approximately 576 million board feet of timber, worth approximately $144 million (gross revenue) for the decade ending in fiscal year 2014.

The Board of Natural Resources periodically sets a statewide sustainable harvest level. However, the OESF is an independent sustainable harvest unit and therefore is given its own harvest level. This harvest level applies to all state trust lands in the OESF; it is not regulated by individual trust or landscape.

The sustainable harvest level for the decade beginning in fiscal year 2015 will be determined through a separate analysis process and submitted for approval to the Board of Natural Resources. As described in the 2006 PSF, the mean annual timber volume for any decade shall not vary more than 25 percent (higher or lower) from the previous decade. If, however, a sustainable harvest unit is in arrears[1] at the end of a decade, DNR can offer the volume of timber that is in arrears for sale in addition to the sustainable harvest level for the following decade. Before doing this, DNR must determine whether it would provide the greatest return for the trusts (considering both current and forecasted economic conditions) and analyze related impacts to the environment (RCW 79.10.330).

Strategies

- Manage the OESF as an independent sustainable harvest unit regardless of trust.[2]
- Calculate a sustainable harvest level (RCW 79.10.300) and periodically adjust it. Submit the sustainable harvest level and any adjustments to the Board of Natural Resources for approval.
- Keep the annual harvest volume within 25 percent (higher or lower) of the decadal mean volume (DNR 2006).
- Identify forestlands that are available for harvest and those that are deferred from harvest[3] and record them in a geographical information system (GIS) database using either the land use or local knowledge feature class.
- Design silvicultural prescriptions, including site-specific harvest activity prescriptions, using professional judgment, local knowledge, and existing guidelines and procedures.
- Document silvicultural prescriptions in DNR's Planning and Tracking database (P&T).

Refer to Chapter 3 for information on DNR's projected harvest volumes and revenues.

Ecological Values

On state trust lands in the OESF, DNR will manage for ecological values primarily by implementing a set of habitat conservation strategies (riparian, northern spotted owls, marbled murrelets, and multispecies). These strategies will be described in detail in the following sections. DNR believes that implementation of the conservation strategies, when combined with active management and harvest deferrals, should result in a productive, healthier, and more biologically and structurally diverse forest that supports ecological values as well as revenue production.

Riparian Conservation Strategy

Introduction

The vision of the riparian conservation strategy for state trust lands in the OESF is to protect, maintain, and restore habitat capable of supporting viable populations of salmonid species and other non-listed and candidate 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 certain riparian functions** important to salmonid habitat. DNR believes, as a working hypothesis, that if it focuses on a subset of riparian functions, it will maintain or aid restoration of *all* riparian functions and processes necessary to meet the habitat needs of salmon and other riparian-dependent species—in other words, habitat complexity.

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.

In the following section, DNR provides its goals, measurable objectives, and strategies for riparian conservation in the OESF.

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 with 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 on their maintenance and restoration in commercial forests.

These goals are based on the 1997 HCP, p. IV.107.

Measurable Objectives

- Maintain or aid restoration of the potential of riparian forests to provide large woody debris to the stream channel.
- Maintain or aid restoration of the potential of riparian forests to provide shade to the stream channel.
- Prevent detectable increases in water quantity (peak flow) during storm events.

- Protect the integrity of riparian forests from damaging winds.

Refer to Text Box A-5 for how objectives will be measured.

Strategies

- Establish interior-core buffers.
- Establish exterior buffers
- Implement comprehensive road maintenance and abandonment plans.
- Protect wetlands.

These strategies are based on the 1997 HCP, p. IV.108.

Together, the interior-core buffer and the exterior buffer (when needed) are known as the "riparian management zone." Riparian management zones are not harvest deferrals; they are areas managed to meet DNR's measurable objectives. Riparian management zones also minimize the effects of upland management activities on riparian areas. The activities allowed in the riparian management zone will be described in the following section.

Text Box A-5. How the Riparian Objectives Are Measured

Large Woody Debris

The ability of the riparian forest to provide large woody debris to the stream channel is known as its **recruitment potential**. Large woody debris recruitment potential is assessed by examining riparian forest composition and structure within the area from which large woody debris originates. The area in question varies depending on the mechanism of delivery. For mechanisms such as landslides and debris flows, this area includes stream-associated unstable slopes and landforms. For mechanisms such as bank erosion, windthrow, and tree mortality, this includes areas within a set distance of the stream channel and its associated floodplain. The distance varies by stream type and measures 150 feet along Type 1 and 2 streams and 100 feet along Type 3 and 4 streams. Riparian forests within this area are classified by their dominant forest taxa (conifer, hardwood, mixed), average tree size (large, medium, or small based on quadratic mean diameter), and stand density (sparse or dense, based on Curtis' Relative Density). These three variables are combined to provide a qualitative assessment (high, medium, or low) of the riparian forest stand's large woody debris recruitment potential. For additional information, refer to the *Standard Methodology for Conducting Watershed Analysis, version 4.0* (Washington Forest Practices Board [WFPB] 1997). During landscape planning, the current and future large woody debris recruitment potential is measured using a forest estate model. Each Type 3 watershed is managed for a non-declining yield[4] for large woody debris recruitment potential, meaning the recruitment potential is either maintained or increased, thus maintaining or restoring the potential of riparian forests to provide large woody debris to the stream channel.

Shade

The ability of the riparian forest to provide shade to the stream channel is known as its **shade potential**. Shade potential is assessed by examining forest structure within 75 feet of Type 1 through 4 streams and their associated floodplains. An index of the riparian forest's shade potential is calculated by multiplying the Reinke's Stand Density Index (SDI) by the average top height of the 40 largest live trees in the stand. This method reflects that dense, tall stands are more likely to provide shade. During landscape planning, the current and future shade potential is measured using a forest estate model. Each Type 3 watershed is managed for a non-declining yield for shade potential, meaning the shade potential is either maintained or increased thus maintaining or restoring the potential of riparian forests to provide shade to the stream channel.

Peak flow

The maximum stream flow, or discharge, during storm events is known as **peak flow**. The potential for management activities to change peak flow is based on an assessment of hydrologic maturity within each Type 3 watershed. Stands must meet two conditions in order to be classified as hydrologically

Text Box A-5, Continued. How the Riparian Objectives Are Measured

mature: 1) they must be at least 25 years of age and 2) they must have a Curtis' Relative Density of at least 25. Stands that meet these criteria are not considered to contribute to higher peak flows. Hydrologic maturity is evaluated within two hydrologic zones[5] per the methods of Grant and others (2008): the rain-dominated and the rain-on-snow zone. Each zone responds differently to changes in hydrologic maturity. During landscape planning, the current and future hydrologic maturity of each Type 3 watershed is assessed. Each Type 3 watershed is managed to avoid detectable increases in peak flow (defined as a ten percent change), preventing detectable increases in water quantity (peak flow) during storm events.

Windthrow

The need for an exterior buffer to mitigate the effects of **damaging winds** is assessed using windthrow probability modeling (Mitchell and Lanquaye-Opoku 2007) combined with remote and field assessments. Damaging winds are defined as those sufficient to significantly compromise or degrade the ability of the riparian forest to provide riparian processes and functions. Damaging winds can occur under a variety of circumstances, and only in some situations can management practices mitigate or prevent the damage. DNR seeks to maintain riparian forest integrity and prevent the loss of riparian function as a result of *severe endemic windthrow*. Endemic windthrow results from routine peak winds with short return intervals (less than five years between events). Damage from endemic windthrow varies from single trees to entire stands, but typically includes more uprooting than stem breakage. Damage is concentrated in areas where stand edges or residual trees have been exposed by harvesting (Zielke and others 2010). Endemic windthrow is strongly influenced by site conditions and silvicultural practices, and can therefore be predicted (Lanquaye 2003). Severe endemic windthrow is defined as windthrow in which at least 90 percent of an area will experience 50 percent or more canopy loss (Mitchell and Lanquaye-Opoku 2007). Exterior buffers are applied to protect the integrity of riparian forests from damaging winds.

By contrast, catastrophic (versus endemic) windthrow results from winds with longer return periods (typically greater than 20 years between events) and is strongly influenced by wind speed, wind direction, and local topographic features. These events damage standing timber (continuous forest without edges) as well as recently exposed stand edges. The damage may include a higher proportion of stem breakage (Zielke and others 2010). Due to their chaotic and stochastic nature, DNR is unable to predict the local likelihood of catastrophic windthrow from stand and site conditions. DNR cannot and does not protect against catastrophic windthrow.

STRATEGIES: DISCUSSION

Establish Interior-Core Buffers

Interior-core buffers are intended to protect and aid restoration of riparian processes and functions. Interior-core buffers accomplish this by 1) minimizing the disturbance of unstable channel banks and adjacent hill slopes, and 2) maintaining forest cover in proximity to streams.

Due to a combination of factors (steep terrain; highly erosive, weathered bedrock; overlying glacial deposits; and heavy annual precipitation), there is a high potential for landslides throughout much of the OESF (DNR 1997). Channel erosion and sedimentation from landslides can adversely impact salmonids and other riparian-dependent species by changing channel morphology and reducing habitat complexity (DNR 1997). For this reason, interior-core buffers will incorporate all unstable slopes or landforms with the potential to deliver sediment or debris to the stream network.

When to Apply the Interior-Core Buffer

DNR will apply interior-core buffers to Type 1 through 4 streams when implementing a variable retention harvest in the adjacent uplands. DNR will apply an interior-core buffer to a subset of Type 5 streams (those located on potentially unstable slopes and landforms).

In accordance with WAC 222-30-021, DNR will also provide additional protection through a 30-foot-wide equipment limitation zone, which will be applied to all streams regardless of whether the stream is on stable or potentially unstable ground. This zone is measured outward from the outer edge of the bank-full width. Equipment use and disturbances are limited in this area.

Configuration of the Interior-Core Buffer

For Type 1 through Type 4 streams on stable ground, the widths of interior-core buffers will be similar to the average buffer widths listed in Table IV.10 in the 1997 HCP (refer to Text Box A-6). As mentioned previously, interior-core buffers will be widened, where necessary, to incorporate all potentially unstable slopes and landforms with the potential to deliver sediment and debris to the stream network. The interior-core buffer also encompasses all channel beds and floodplains that have the potential to trap sediment and other materials carried downstream by debris flows and associated dam-burst floods. Potentially unstable slopes and landforms will be identified through field reconnaissance or use of slope geomorphology models, and will be verified, as necessary, through field reconnaissance with qualified staff.

Text Box A-6. Interior-Core Buffers Under the Landscape Alternative

For stream types 1 through 4 on stable ground, the 1997 HCP (DNR 1997 p. IV.123) lists the following average widths for interior-core buffers:

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

These buffer widths are the same for every Type 3 watershed and are based on the buffer widths proposed in the literature for several key watershed parameters. Buffers are measured outward from the outer edge of the 100-year floodplain and the floodplain itself is considered part of the buffer.

A small amount of variable retention harvest is allowed within the interior-core buffer if such harvest does not impede riparian function. The amount (number of acres) is determined through a watershed assessment process in the forest estate model (refer to Appendix D of the RDEIS). The amount is relatively small: on average, only 2 percent of the riparian forest buffers in any given Type 3 watershed may be harvested by variable retention harvest methods. In the following discussion, DNR refers to these acres as “allowed acres of variable retention harvest.”

The number of acres of allowed variable retention harvest is specific to each Type 3 watershed (refer to Appendix A-2). The number of acres is not dependent on stream type and is updated periodically.

To provide operational flexibility, foresters are given two options on where to place the allowed acres of variable retention harvest. Foresters may choose either option (refer to Figure A-2).

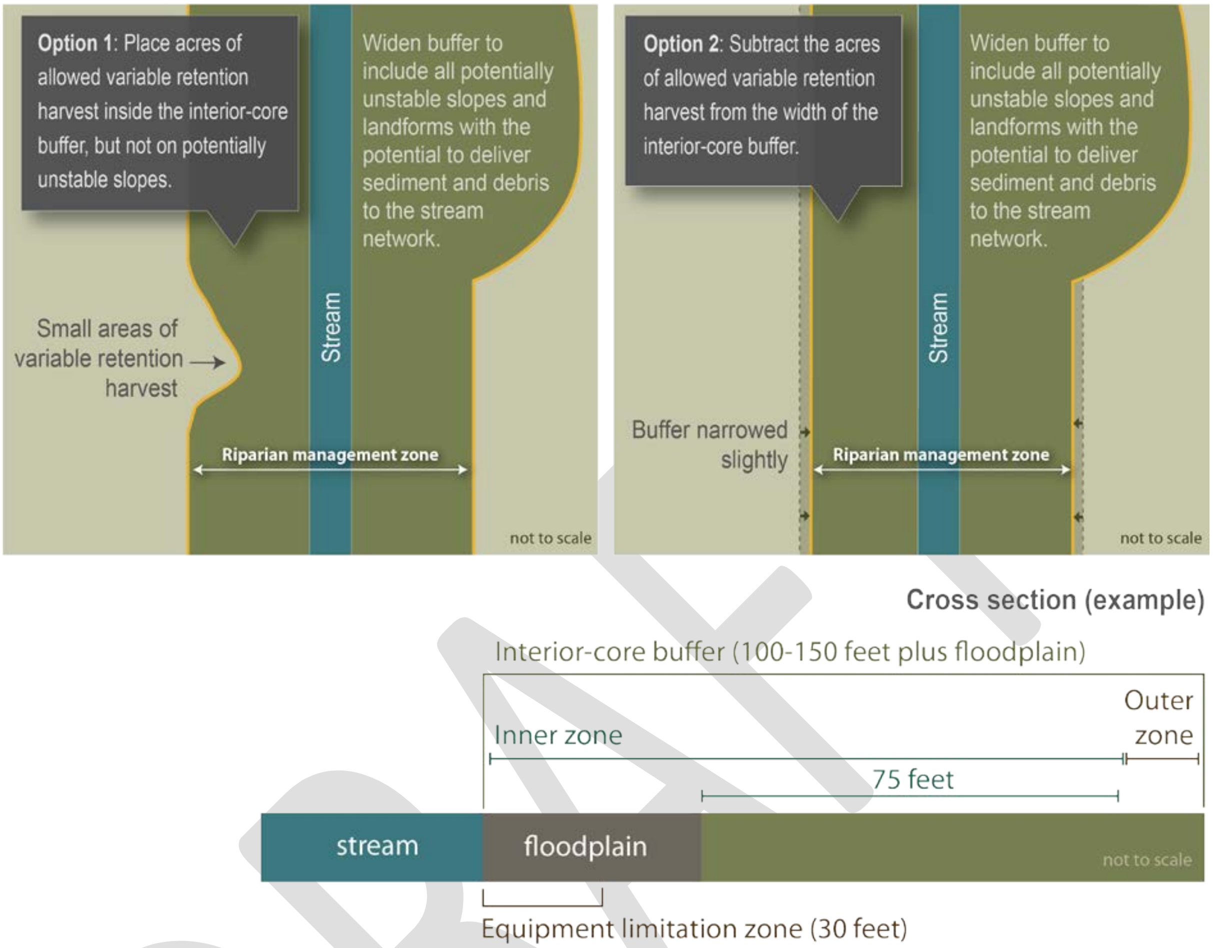
- **Option 1, interior-core buffer with small areas of variable retention harvest:** Under this option, foresters place allowed acres of variable retention harvest within the interior-core buffer, but not on potentially unstable slopes. The allowable variable retention harvest total is reported within two distance intervals: an inner zone (which includes the 100-year floodplain and 75 feet of the interior-core buffer, measured from the outer edge of the floodplain) and an outer zone (the remainder of the interior-core buffer).

- **Option 2, adjusted-width interior-core buffer**: Under this option, no variable retention harvest is allowed inside the interior-core buffer except for rights-of-way for roads or salvage in the case of a natural disturbance (refer to the draft procedure “Response to Natural Disturbances in the OESF Habitat Conservation Plan (HCP) Planning Unit” in Appendix A-3). Instead, foresters subtract the acres of allowed variable retention harvest from the width of the interior-core buffer. On average, the interior-core buffer is narrowed by approximately 2 percent. The adjusted-width interior-core buffers for each stream type in each Type 3 watershed can be found in Appendix A-2. Widths are different for each watershed and may be updated periodically.

Under both options, the width of the interior-core buffer is considered an average rather than absolute value because the size and configuration of the buffer must vary locally to accommodate terrain and forest stand characteristics.

DNR will re-run the forest estate model periodically to reflect updated information. DNR will recalculate the acres of allowed variable retention harvest for future decades each time the model is re-run.

Figure A-2. Riparian Forest Buffer Options for Stream Types 1 Through 4 on Stable Ground



Other Management Activities in the Interior-Core Buffer

In addition to variable retention harvest (as explained in the previous section), the following management activities are permitted inside interior-core buffers on state trust lands in the OESF. To be allowed, these activities must either support or not detract from the measurable objectives of the riparian conservation strategy:

- Pre-commercial thinning
- Variable density thinning (allowed under either option)
- Selective harvest of hardwoods and/or removal of single hardwood trees
- Restoration efforts, including habitat-enhancement projects such as the creation of snags, dead down wood and in-stream large woody debris
- Research projects designed to improve the integration of revenue and ecological values
- Application of herbicides in accordance with WAC 222-38-020, *Handling, Storage, and Application of Pesticides*

- Road crossings over streams; to minimize cumulative impacts associated with roads, DNR will design roads to take the most direct route over streams that is operationally feasible.

Establish Exterior Buffers

Exterior buffers are designed to protect the integrity of the interior-core buffer from the loss of riparian function that results from severe endemic windthrow. Severe endemic windthrow is defined as windthrow in which 90 percent of an area will experience 50 percent canopy loss (Mitchell and Lanquaye-Opoku 2007).

It is neither expected nor intended that the exterior buffer will prevent all windthrow from occurring in the interior-core buffer. Windthrow in streamside forests is a normal occurrence, and serves as an important mechanism for the recruitment of large woody debris to the stream channel. However, DNR relies on interior-core buffers to maintain a range of ecosystem functions, which may be compromised if excessive windthrow occurs.

When to Apply the Exterior Buffer

The need for an exterior buffer is based on an assessment of the likelihood of severe endemic windthrow. For this assessment, DNR reviews general wind and windthrow trends in the area of interest; assesses topographic, stand, soil, and proposed treatment conditions in the field; and evaluates windthrow probability using a predictive model that is specifically designed and calibrated for use on the Washington coast (Mitchell and Lanquaye-Opoku 2007). DNR uses the model to a) identify Type 3 watersheds with the highest probability for severe endemic windthrow, b) assess the probability of severe endemic windthrow along the proposed harvest unit boundary, and c) identify segments of riparian forest buffers that are most susceptible to severe endemic windthrow.

Regardless of stream type, exterior buffers will be placed on all segments of interior-core buffers for which the likelihood of severe endemic windthrow is deemed unacceptable. DNR defines the acceptable likelihood as 5 percent. All segments of riparian buffers with a 5 percent or greater chance of experiencing severe endemic windthrow, defined as 90 percent of the interior core predicted to experience 50 percent canopy loss, will be protected with an exterior buffer. Those with less than a 5 percent chance of experiencing severe endemic windthrow will not receive an exterior buffer.

A number of factors promote susceptibility to windthrow on the western Olympic Peninsula. Mitchell and Lanquaye-Opoku (2007) found that the proportion of edge segments damaged 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[6] of at least 100 meters. 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.

Configuration of the Exterior Buffer

Where applied, the exterior buffer measures 80 feet (horizontal distance) from the outer edge of the interior-core buffer. The dimensions of the exterior 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 provides. The width of the exterior 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 damage extended further than 25 meters (82 feet) into the edge, and less than 10 percent of the damage extended beyond 50 meters (164 feet) into the edge.

The width of the exterior buffer is considered an average rather than absolute value because the size and configuration of the exterior buffer must vary locally to accommodate terrain and stand characteristics.

Management Activities in the Exterior Buffer

Management activities in the exterior buffer are designed to produce and maintain forest stands that are wind-firm, robust, and structurally and compositionally diverse. The management activity most likely to occur in exterior buffers on state trust lands in the OESF is variable density thinning. The spacing of tree removal will be determined in the field by the forester or land manager using information from the following: an assessment of the physical and biological conditions of each site, an assessment of the likelihood of severe endemic windthrow (refer to previous section), and the stated riparian conservation measurable objectives. Forest structure modifications, including uniform thinning, pruning, and tree-topping to improve wind firmness, may also be utilized, as will pre-commercial thinning and restoration activities as appropriate.

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. To protect water quality and riparian habitat, roads must be constructed and maintained in a manner that will prevent potential or actual damage to public resources. This protection will be accomplished by constructing and maintaining roads in a way that does not result in delivery of sediment and surface water to any typed water in amounts, at times or by means, that preclude achieving desired fish habitat and water quality.

Comprehensive road maintenance and abandonment plans are intended to minimize adverse impacts to the environment from roads. The objectives are to (DNR 1997, p. IV.118):

- Conduct annual inventories of road conditions.
- Maintain existing roads to minimize drainage problems and stream sedimentation.
- Stabilize and close access to roads that no longer serve a management function or that cause intractable management or environmental problems.
- Assure sound construction of any new roads.
- Guarantee that additional new roads are built only where no other operationally or economically viable option exists for accessing management areas, either by existing roads or alternative harvest methods (such as full-suspension yarding).

- Minimize active road density.[7]
- Prioritize roads for decommissioning, upgrading, and maintenance.
- Identify fish blockages caused by stream crossings and prioritize their retrofitting or removal.

Washington State forest management laws require large forest landowners,[8] including DNR, to prepare and submit road maintenance and abandonment plans. 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 road maintenance and abandonment plans for each of the 11 landscapes in the OESF and is in the process of implementing them. 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 (Washington Forest Practices Board [WFPB] 2001).

Suspension of Timber Hauling During Storm Events

In addition to road maintenance and abandonment plans, DNR also considers how operations can be adjusted to further prevent delivery of fine sediment to streams. For example, DNR suspends timber hauling on state trust lands in the OESF during storm events, when heavy rainfall can potentially increase surface water runoff and sediment delivery. 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. If timber hauling is suspended, DNR monitors the road to determine if potential problems are developing that may lead to sediment delivery to streams and takes action as necessary.

Protect Wetlands

Wetland protection on state trust lands in the OESF is intended to maintain, and in some cases restore, wetland hydrologic processes and functions. 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 that Require Protection

Forested and non-forested wetlands (including bogs), as defined by WAC 222-16 definitions,[9] will be protected on state trust lands in the OESF. Wetlands larger than 0.25 acres and bogs larger than 0.1 acres will be protected with buffers and special management considerations (DNR 1997, p. IV.120). Series of smaller wetlands will be protected if they function collectively as a larger wetland.

Size and Configuration of the Wetland Buffer

The recommended buffer width depends on the size of the wetland in question (refer to Table A-4).

Table A-4. Recommended Buffer Width for Wetlands (Forested and Non-Forested, Including Bogs) on State Trust Lands in the OESF (DNR 1997, p. IV.120)

Size of wetland	Recommended buffer width
Greater than 5 acres	Equal to the site potential tree height of riparian forests in the OESF
0.25 acres to 5 acres (forested and non-forested wetlands) **0.1 to 5 acres (bogs)**	Equal to two-thirds of the site potential tree height of riparian forests in the OESF

Management Activities Permitted Within Wetlands and Their Buffers

Harvesting in wetlands and wetland buffers can occur, provided that management activities are consistent with the riparian conservation measurable objectives and follow the level of protection outlined in Table A-5.

Table A-5. Wetland Protection

Wetland type	Protection
Forested	• Maintain and perpetuate a stand that is wind firm. • Retain and perpetuate at least 120 square feet of basal area per acre.
Non-forested	• Leave a 50-foot no-harvest zone around the non-forested wetland. Measure the 50 feet from the beginning of the forested area. • For harvest within buffers beyond the 50-foot no-harvest zone, maintain and perpetuate wind firmness per the recommendations for harvest in exterior buffers. • Select leave trees that are representative of the dominant and co-dominant pre-harvest tree species.

For wetlands in areas susceptible to windthrow, a primary conservation objective is the maintenance of wind-firm stands. Experiments to design harvests to achieve wind-firm stands may be considered in these areas (DNR 1997, p. IV.120). Projects of this nature would be conducted through the research and monitoring program as part of the adaptive management process. Refer to Chapter 4 of this forest land plan for an explanation about how DNR will identify and prioritize adaptive management questions such as how to achieve wind-firm stands.

In order to assure that there is no net loss of wetland function, all road and landing construction near or within wetlands will be conducted in accordance with WAC 222-24 *Road Construction and Maintenance* and the guidance for wetlands provided in the 1997 HCP (p. IV.69 and IV.119). Roads shall not be constructed in bogs or low nutrient fens. No road building will occur in other wetland types or wetland buffers without mitigation, and roads constructed within wetlands or wetland buffers will require on-site and in-kind equal-area mitigation. The effects of roads on natural surface and subsurface drainage will be minimized. Roads will be designed to take the most direct route operationally feasible across wetlands to minimize the cumulative impacts associated with roads.

Forestry operations in wetlands and wetland buffers will be in accordance with DNR's policy of no net loss of wetland acreage or function. Forestry operations in forested wetlands and in buffers of non-forested wetlands 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 (such as tractors with low pressure tires). 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 be required. Soil compaction and rutting usually preclude the use of ground based equipment in wetland areas. Salvage operations will be allowed within wetland buffers in areas that are not periodically flooded (DNR 1997, p. IV.70). The use and application of herbicides within wetlands will be in accordance with WAC 222-38-020.

Northern Spotted Owl Conservation Strategy

Introduction

The northern spotted owl was listed as threatened under the Endangered Species Act in 1990. This 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. For a description of northern spotted owl biology, refer to Chapter 3 of the 1997 HCP. The 1997 HCP includes conservation goals and mitigation strategies for the northern spotted owl (DNR 1997, p. IV.80 through IV.106).

Goals

- Restore a level of habitat capable of supporting reproducing northern spotted owls 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 commercial forests, including their occupancy by successfully reproducing northern spotted owls that are a functional segment of the Olympic Peninsula sub-population.

Goals are based on the 1997 HCP, p. IV.86 through IV.87.

Measurable Objectives

The overall management objective for the northern spotted owl conservation strategy is to restore and maintain, by the year 2067, minimum thresholds of northern spotted owl habitat (refer to Text Boxes A-7 and A-8) in each of the eleven landscapes in the OESF. DNR will:

- Restore and maintain at least 40 percent of state trust lands in each landscape in Young Forest or better northern spotted owl habitat types, which includes Old Forest Habitat.[10]
- Restore and maintain at least 20 percent of state trust lands in each landscape in Old Forest Habitat.[11]

Text Box A-7. Old Forest Habitat

Old Forest Habitat is defined as forests that meet the structural definitions of high quality nesting habitat, Type A habitat, and Type B habitat. These definitions are presented in Tables A-6 through A-8. These habitat types are described in the 1997 HCP (p. IV.11 through IV.12). To identify forest stands that meet these descriptions, DNR correlates these habitat attributes with inventory attributes in DNR's Forest Resource Inventory System (FRIS).

Old Forest Habitat was also mapped by DNR Olympic Region biologists (Scott Horton pers. comm.) from aerial photographs and field surveys related to marbled murrelet surveys. Those areas are included as Old Forest Habitat even though they do not meet the FRIS inventory conditions listed for high quality, Type A habitat, or Type B habitat.

Table A-6. High Quality Nesting Habitat Description and Inventory Attributes

High quality nesting habitat description	Inventory attributes
• At least 31 trees per acre are greater than or equal to 21 inches diameter at breast height (dbh) with at least 15 trees, of those 31 trees, per acre greater than or equal to 31 inches dbh • At least three trees have broken tops • Canopy closure at least 70% • A minimum of 5 percent ground cover of large woody debris	• At least 3 live trees per acre >21inches 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 2,400 cubic feet per acre down wood

Table A-7. Type A Habitat Description and Inventory Attributes

Type A habitat description	Inventory attributes
• A multi-layered, multispecies canopy dominated by large (30 inches diameter or greater) overstory trees • 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 woody debris 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 75 to 100 trees per acre >20 inch dbh • 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 • Curtis's Relative Density >= 48

Text Box A-7, Continued. Old Forest Habitat

Table A-8. Type B Habitat Description and Inventory Attributes

Type B habitat description	Inventory attributes
• Few canopy layers, multi-species 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 trees with various deformities • Large (greater than 20 inches diameter) snags present • Large accumulation of fallen trees and other woody debris 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 • Large trees with various deformities • At least 1 live trees per acre > 21 inches with broken top • At least 1 snag/ac >20" dbh and 16 feet tall • One or more snags per acre >20 inches dbh and 16 feet tall • At least 2,400 cubic feet per acre down wood • Curtis's Relative Density >= 48

Text Box A-8. Young Forest Habitat

Young Forest Habitat is defined as forests that meet the structural definitions for sub-mature and young forest marginal habitat. These definitions are presented in Tables A-9 and A-10. These habitat types are described in the 1997 HCP (p. IV.11 through IV.12). To identify forest stands that meet these descriptions, DNR correlates these habitat attributes with inventory attributes in DNR's FRIS.

Table A-9. Sub-Mature Habitat Description and Inventory Attributes

Sub-mature description	Inventory attributes
• 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 of between 115 and 280 trees greater than 4 inches • Trees over 85 feet tall • At least three snags per acre that are at least 20 inches in diameter	• 30 and or more percent conifer trees per acre • 115 to 280 trees per acre >4 inches dbh class • Minimum top height of 40 largest trees >85 feet tall • Curtis's Relative Density >= 48 • At least 3 snags per acre >20 inches dbh and 16 feet tall • At least 2,400 cubic feet per acre down wood

Text Box A-8, Continued. Young Forest Habitat

Table A-10. Young Forest Marginal Habitat Description and Inventory Attributes

Young forest marginal description	Inventory attributes
• 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 of between 115 and 280 trees greater than 4 inches • 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 wood with 25 to 60 percent shrub cover	• 30 percent or more conifer trees per acre • 115 to 280 tree per acre >4” dbh class • Minimum top height of 40 largest trees >85 feet tall • Curtis's Relative Density >= 48 • At least 2 snags per acre >20 inches dbh and 16 feet tall or at least 4,800 cubic feet per acre down wood

Strategies

- Follow the restoration and maintenance phases for northern spotted owl habitat conservation.
- Develop and maintain Old Forest Habitat.
- Develop and maintain Young Forest Habitat.
- Manage non-habitat forest stands to develop into northern spotted owl habitat.

STRATEGIES: DISCUSSION

Restoration and Maintenance Phases

The 1997 HCP identifies two phases for meeting northern spotted owl habitat conservation objectives: the restoration phase, and the maintenance and enhancement phase. The restoration phase is defined as the time it takes a landscape to reach 40 percent Young Forest Habitat or better.[12] [13] Refer to Table A-11 for the projected decade in which thresholds will be met in each landscape.

Once the minimum habitat threshold of 40 percent Young Forest Habitat and better has been achieved, the landscape will enter the maintenance and enhancement phase.[14] DNR anticipates that Old Forest habitat will continue developing to at least 20 percent of each landscape during this stage. The maintenance and enhancement phase remains in effect for the remainder of the 1997 HCP permit period (to the year 2067).

Old Forest Habitat

Old Forest Habitat contains structural elements that provide a variety of functions, such as nesting, roosting, foraging, and movement, that are important to northern spotted owls (refer to Text Box A-7).

Old Forest Habitat is not available for harvest activities unless the following conditions are met:

- Minimum northern spotted owl habitat thresholds have been met and maintained (40 percent of the landscape in Young Forest Habitat or better with at least 20 percent in Old Forest Habitat) in the landscape, and
- The 2006 Settlement Agreement[15] has expired.

Young Forest Habitat

Young Forest Habitat contains structural elements that provide a variety of functions, such as movement, foraging, and roosting, that are important to northern spotted owls (refer to Text Box A-8).

During the restoration stage (before a landscape has reached 40 percent Young Forest or better habitat), Young Forest Habitat is available for harvest activities when it has been demonstrated, through forest estate modeling, that the proposed harvest activity in Young Forest Habitat will not change the decade in which the landscape is projected to be restored (at least 40 percent Young forest and better habitat) (refer to Table A-11 for the projected trajectories).

Road Building in Young Forest Habitat

Road building through Young Forest Habitat is allowed before the landscape has reached the 40 percent minimum habitat threshold so long as it does not change the decade in which the threshold will be met. If road building in Young Forest Habitat *does* change the decade restoration is achieved, then harvesting Young Forest habitat for road building will not exceed one percent of the amount of Young Forest Habitat within the landscape.

Table A-11. Decades That Landscapes Meet the Northern Spotted Owl Habitat Minimum Threshold

Landscape	Decade 20 percent Old Forest Habitat threshold is met	Decade 40 percent Young Forest Habitat and better threshold is met
Clallam	5	1
Clearwater	0	5
Coppermine	7	6
Dickodochtedar	4	2
Goodman	0	3
Kalaloch	5	4
Queets	0	4
Reade Hill	0	1
Sekiu	6	5
Sol Duc	8	2
Willy Huel	0	6

Non-Habitat Forest Stands

Forest stands that are not northern spotted owl habitat are available for harvest. However:

- When and where feasible, harvests activities and other silvicultural activities in young stands should promote the development of Young Forest or Old Forest Habitat, so that the restoration phase is expedited (DNR 1997, p. IV. 99).

- Harvest activities should be consistent with objectives for other 1997 HCP habitat conservation strategies, such as riparian or marbled murrelet. In the northern spotted owl conservation strategy in the 1997 HCP, there is an assumption that northern spotted habitat will develop over time in areas managed to meet the objectives of the riparian and marbled murrelet conservation strategies.
- Each landscape has a different amount of northern spotted owl habitat due to the landscape's general ecological condition and past timber harvesting. The amount of time required for restoration is unique to each landscape. Note that the Sol Duc landscape almost meets the thresholds for Old Forest Habitat in the fifth decade, but it is just below the threshold until the eighth decade (Table A-11).

For a discussion on DNR's approach to mapping northern spotted owl habitat in the OESF, refer to Appendix A-6.

Marbled Murrelet Conservation Strategy

Introduction

At the time the 1997 HCP was adopted, DNR did not have enough information to develop a conservation objective and strategy for marbled murrelets. DNR is currently developing the long-term Marbled Murrelet Conservation Strategy in a separate planning process. The current strategy incorporated into this plan is based on direction provided in the "Memorandum for Marbled Murrelet Management within the Olympic Experimental State Forest" dated March 7, 2013.

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.

In accomplishing this goal, DNR expects to make a significant contribution to maintaining and protecting marbled murrelet populations.

Measurable Objective

Protect occupied sites and reclassified habitat[16] until a long-term conservation strategy for marbled murrelet habitat is developed.

Strategies

- Implement existing 1997 HCP obligations through guidance provided in the "Memorandum for Marbled Murrelet Management within the Olympic Experimental State Forest" dated March 7, 2013. The purpose of this memorandum is to protect marbled murrelet habitat and allow timber harvest and other activities to proceed while the long-term strategy is being developed. A copy of this memorandum is provided in Appendix A-3.
- Implement the long-term strategy when it is completed.

Multispecies Conservation Strategy

Introduction

DNR believes that it can meet the needs of unlisted wildlife species by implementing integrated management and additional site- or species-specific conservation measures in response to certain circumstances (DNR 1997, p. IV.135). As explained in Chapter 1, integrated management includes actively managing as many areas as possible and deferring others; implementing the major conservation strategies (northern spotted owls, riparian, marbled murrelets); planning from a landscape perspective; and conducting research, monitoring, and adaptive management.

Goals

- Develop and implement land-management plans that do 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 diverse array of habitat conditions to support multispecies goals through measurable objectives for northern spotted owls, marbled murrelets, riparian areas, and revenue production.

Strategies

- Follow existing procedures and guidelines for unique habitats.
- Manage habitat for unlisted species of concern.

DISCUSSION

Some unlisted 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 1997 HCP, and on-the-ground guidance is given in DNR's Forestry Handbook. All harvest activities must comply with the following unique habitat procedures and guidelines:

- Identifying and Managing Structurally Complex Forests to Meet Older Forest Targets (Westside) (PR 14-004-046)
- Protecting Talus Fields (PR 14-004-170)
- Wetland Management (PR 14-004-110)
- Management of Forest Stand Cohorts (PR 14-006-090)

- Old-growth Timber Harvest Deferral and Protection (Westside) (GL 14-004-010)
- Protecting Mineral Springs (PR 14-004-230)
- Protecting Cliffs (PR 14-004-190)
- Protecting Caves (PR 14-004-180)
- Protecting Balds (PR 14-004-2200)

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). All harvest activities must comply with the following unlisted species of concern procedures:

- Wildlife Habitat (PO 14-009)
- Protecting Pileated Woodpecker Nests (PR 14-004-290)
- Protecting Vaux's Swifts Nests and Night Roosts (PR 14-004-300)
- Protecting Peregrine Falcon Habitat (PR 14-004-340)
- Protecting Pacific Fisher Dens (PR 140-004-280)
- Protecting Northern Goshawk Nest West of the Cascades (PR 14-004-260)
- Protecting Myotis Bat Communal Roosts and Maternal Colonies (PR 14-004-310)
- Protecting Harlequin Duck Nests (PR 14-004-250)
- Protecting Northern Goshawk Nests West of the Cascades (PR 14-004-260)
- Protecting Common Loon Nests (PR 14-004-240)
- Protecting Bald Eagle Nesting , Roosting, and Foraging Sites (PR 14-004-330)
- Protecting Aleutian Canada Goose Habitat (PR 14-004-390)

Research, Monitoring and Adaptive Management

Introduction

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 OESF was designated with the unique mission to intentionally learn how to integrate revenue production and ecological values across the landscape. This learning happens through research, monitoring, and information sharing. New knowledge is used to improve forest management through a formal adaptive management process.

Goal

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

Measurable Objective

- Establish a formal adaptive management process in which incomplete knowledge (uncertainties) is identified, hypotheses around desired outcomes are formulated, actions to test these hypotheses are implemented, and reliable information is used to consider management adjustments.
- Conduct implementation, effectiveness, and validation monitoring and research according to commitments in the 1997 HCP.

Through this forest land planning process, DNR updates and in some cases specifies or clarifies the information needs presented in the 1997 HCP. Identifying and discussing key uncertainties and adaptive management questions (refer to Chapter 4) is an important contribution of the draft forest land plan as it provides a fresh focus for OESF research and monitoring. The order in which uncertainties will be addressed is determined through the prioritization criteria described in Chapter 4.

Strategies

- Implement an adaptive management procedure which institutionalizes the adaptive management process (refer to the draft adaptive management procedure in Appendix A-3).
- Conduct effective information management, which includes documenting operational, research, planning, and policy activities; making records easily accessible; and exchanging information within DNR and with external partners.
- Conduct implementation monitoring to determine whether the 1997 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).
- 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.

For additional information regarding adaptive management, monitoring, and research, refer to Chapter 4 and Appendices A-1 (Information Management), A-3 (Draft Procedures), A-4 (Implementation Monitoring), and A-5 (Riparian Validation Monitoring).

[1] A sustainable harvest unit is considered to be in arrears when the volume of timber harvested during a sustainable harvest planning decade is less than the sustainable harvest level for that decade. An arrearage may occur as a result of a contractor defaulting on a timber sale contract, DNR not selling the amount of timber necessary to meet the sustainable harvest level, or a combination of these (RCW 79.10.300).

[2] DNR will calculate, and the Board will adopt, a separate long-term decadal sustainable harvest level for each of several distinct sustainable harvest units. DNR will express the sustainable harvest level for a given unit as a mean annual timber volume for a planning decade (DNR 2006, p. 29).

[3] DNR will follow PR 14-004-010, Identifying Off-base Land. Lands are designated as either short-term or long-term deferrals in the sustainable harvest calculation and, while not currently available for harvest, are included in the calculation. For example, many old-growth stands help meet older-forest targets for the planning unit, but are not available for harvest (DNR 2006, p.30)

[4] A non-declining yield refers to a flow of goods or services (in this case, large woody debris recruitment potential) that does not decrease in successive periods (Society of American Foresters, Dictionary of Forestry).

[5] A hydrologic zone is a spatial classification that groups the portions of the landscape that share common hydrologic processes such as precipitation type and seasonality, hydraulic conductivity and residence times, and partitioning of surface and subsurface flow (Winter 2001 as cited in Grant and others 2008).

[6] Fetch is the length of 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.

[7] Restrict vehicle access to roads that are not currently being used.

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

[9] WAC 222-16 includes references to Section 8 of the Forest Practices Board Manual. Section 8, describing wetland delineation, is based on the 1987 US Army Corp of Engineers Wetland Delineation Manual, which was updated in 2008 through a series of regional supplements. As of 2010, the federal government requires the new delineation supplements to be used for any federal projects, and the Washington State Department of Ecology requires their use for any activities associated with the Growth Management and Shoreline Management acts. While the new delineation guidance is not currently required by law on state-managed timber sales, DNR recommends that the field indicators from the applicable *Regional Supplement for the Western Mountains, Valleys and Coast Region* be adopted within the OESF for use with the Forest Practices board manual (to substitute for the 1987 field indicators), because they provide a much more comprehensive toolbox for foresters that is easier to apply.

[10] At least 40 percent of state trust lands in the landscape in the stem-exclusion to old-growth stages that are potential Old Forest, sub-mature, or young forest marginal northern spotted owl habitat types (Hanson and others 1993), including any Old Forest Habitat (DNR 1997, p. IV. 88).

[11] At least 20 percent of state trust lands in the landscape in the understory-reinitiation to old-growth stages that are potential Old Forest Habitat (DNR 1997 p. IV. 88).

[12] CLARIFICATION FROM THE 1997 HCP, MANAGEMENT DURING THE RESTORATION PHASE (DNR 1997, p. IV.91): The restoration phase for northern spotted owls is the time period it will take to achieve the 20/40 minimum thresholds within each of the 11 landscapes in the OESF. This period was predicted in the 1997 HCP to take between 40 to 60 years, during which time existing young stands would develop characteristics of Young Forest Habitat (described in the Northern Spotted Owl Procedure). Since the adoption of the 1997 HCP, DNR has moved away from using stand age as a surrogate for habitat to an inventory-based evaluation of forest characteristics for habitat identification. This was done because it is more precise than stand age at identifying habitat. Classifying habitat by age generally over-estimates the amount of habitat present when compared to classifying habitat through forest structures identified with forest inventory data. This appears to be especially true for Young Forest Habitat because when inventory was used to evaluate if a stand was habitat, places identified as habitat by age in fact often lacked structural elements of habitat (such as down wood). This over-estimation of habitat, resulting from using stand age in the 1997 HCP, also affects the predicted decade for reaching the 20/40 thresholds.

[13] DNR's interpretation of "restoration" based on p. IV.91 of the 1991 HCP.

[14] During the maintenance and enhancement phase, some stands will continue developing the characteristics of Old Forest Habitat to meet conservation needs for riparian ecosystems, marbled murrelet habitat, and other ecosystem functions. Other stands will receive a variety of silvicultural treatments including stand replacement harvests where appropriate, but total spotted owl habitat will make up at least 40 percent of each landscape. Forest management activities will 1) support necessary riparian ecosystem or marbled murrelet conservation; 2) maintain or enhance at least 20 percent cover of Old Forest Habitat in each landscape , including the maintenance or development of interior Old Forest conditions; and (3) maintain the proportion of Young and Old Forest Habitat at or above 40 percent of each landscape. New research goals will evolve to ensure the success of this phase.

[15]The Settlement Agreement allows no harvest in the "old forest" habitat identified in Appendix A of the Settlement Agreement.

Chapter 3

Silviculture and Implementation

In this chapter of the draft forest land plan, DNR provides information on the forest estate model, silvicultural terms used in this plan, the silvicultural system DNR will use, silvicultural regimes and treatments, projected harvest volumes and revenues, and the expected outcomes for each landscape including age class distribution, riparian conditions, and northern spotted owl habitat.

Silviculture and the Forest Estate Model

In the following section, DNR explains the role of the forest estate model in plan implementation, defines the silvicultural terms that will be used in this plan, and explains the differences between silviculture as it is modeled and as it is implemented on the ground.

The Role of the Forest Estate Model in Plan Implementation

Traditionally, selection of areas to reconnaissance for a prospective timber sale was based on a forester's local knowledge. The forester examined existing information, such as forest inventory, aerial photography or other information, and then visited the site to verify if the area could and should be harvested. The forester then delineated a forest management unit (FMU), determined the management objectives for the FMU, and developed a silvicultural prescription. Seldom could the sale planning process encompass more than three to five years into the future, which left a rather large degree of uncertainty attached to long-term and landscape-level objectives.

As DNR's management objectives have increased in number and complexity, it has become increasingly difficult to meet them using such traditional approaches. Today, these challenges are best met with the assistance of computer models. While silviculture can be used to accomplish objectives on the ground, the diverse set of DNR's management objectives can only be considered comprehensively and simultaneously at large time and spatial scales through computer modeling. As explained in Chapter 1, the primary model DNR uses is the forest estate model.

The forest estate model provides information on three fundamental concerns that are critical to planning timber harvests in a sustainable manner: where to harvest, how to harvest, and how to ensure that objectives are being met. The model conducts a structured and systematic analysis to determine the type and timing of harvests that will best meet DNR's objectives for revenue generation and ecological values. The forest estate model provides:

- A harvest schedule, which is a list and location of potential harvest units and suggested harvest methods (for example, thinning or regeneration harvest) for those units, by decade; and
- A state of the forest file, which provides information about the relative contribution of each harvest unit to DNR's objectives, now and into the future.

The Harvest Schedule Is Only a Guide

The harvest schedule provides an "optimal" harvest planning solution which significantly increases DNR's confidence in meeting its objectives. However, *it is a guide, not a blueprint.* The harvest schedule suggests where and when to harvest timber to best accomplish DNR's objectives for revenue production and ecological values, and serves as a starting point for locating and designing timber sales. However, it is not prescriptive in either the timing or physical location of harvests, nor does it do the job of the professional forester, who retains responsibility for the final decision of which FMUs to harvest, by what method, and when. Foresters make these decisions through a deliberate process using available information from the forest estate model, site visits, and professional judgment. Decisions are based on numerous factors including site, operational, and market conditions. The forester also writes a silvicultural prescription which identifies the practices necessary to ensure DNR meets its objectives (silvicultural prescriptions will be described later in this section).

Model Updates

DNR expects that, during the development of every timber sale, deviations from modeled harvests will occur if deemed appropriate by the forester. Deviations from the harvest schedule come with some risk to the optimal solution suggested by the model, since future harvests are predicated on accomplishment of harvests as they were modeled. Deviations interrupt the scheduled sequence of harvest methods and locations, which in turn affect the accomplishment of current or future objectives.

Consequently, as deviations mount and time passes, their effects on the solution will be compounded. To account for actual activities and changes in resource information (for example, new forest inventory, new stream mapping, and other data), DNR expects to re-run the forest estate model periodically. Ideally, the model will be re-run every two years or at an interval no longer than 10 years to account for the deviations mentioned, and also to keep current with policy changes, science advances, or other developments.

Simplifications in the Forest Estate Model

It is important for DNR's foresters to understand some of the simplifying assumptions that were made when the forest estate model was constructed. This understanding will help foresters utilize the information provided by the forest estate model and better understand the scope of their responsibilities in delineating an FMU and developing its silvicultural prescription.

One example is the difference between silviculture as modeled, and silviculture as practiced on the ground. For example, in developing yield tables in the model for forests regenerated after a simulated timber harvest, DNR assumed that certain silvicultural activities, such as vegetation management and precommercial thinning, will occur, such that the regenerated forest represents a well-stocked, planted or naturally regenerated stand.

In the model, only a certain number of decisions can be made, and most of those decisions are related to timber harvest activities: whether to thin, regenerate, or not harvest. Only a few decisions are related to young stand silviculture, such as regeneration methods (planting versus natural regeneration, species and planting densities, site preparation), vegetation management, and precommercial thinning. The effects of young stand silvicultural decisions are implied in the model and adjusted as coefficients. For purposes of this discussion, the terms “actual” and “modeled” will be used. The use of specific terminology with clearly understood meanings will help DNR distinguish between these two concepts.

Perhaps the most significant simplification is the effort to model the effects of competition between trees retained both within a stand being harvested, and adjacent to it, through a calculation of edge density. Edge density is the ratio between the length of the harvest unit’s boundary and its area, and indicates the complexity of the unit’s shape. Edge density affects volume growth, choice of regeneration, young stand development, and other aspects of forest growth. This issue will be discussed in detail later in this chapter.

It is also useful to clarify how specific terminology relates to the growing environment that will exist on the ground, and how that terminology is represented in the forest estate model. For example, specific levels of edge density are used to distinguish between modeled regeneration methods. However, edge density is not used to inform actual regeneration choices, which are based on site specific considerations that include the type of competition represented by edge density. Frequently used terms such as silvicultural prescription, activities, treatments, regimes, and systems are defined in the following section because modeled silviculture is all implicit rather than represented as explicit choices.

Definitions of Silvicultural Terms Used in this Plan

Silviculture is the art and science of managing forests to accomplish objectives. 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. As a scientific discipline, silviculture is associated with a standard lexicon or library of terminology with specific meanings. Traditional silvicultural definitions were largely intended to easily and clearly convey important information about the activities being conducted or the methods being used, such as clearcut or shelterwood systems.

In recent years, with the emphasis on divergent objectives ranging from revenue production to ecological values, traditional silviculture definitions have proved inadequate to describe the complex treatments being employed. In response, new terms have been introduced but have not been widely accepted. Examples include clearcut with reserves (British Columbia Ministry of Forests and Range 2013), fuzzy clearcut (Powell 2013) and ecosystem based harvesting (Daishowa-Maruben International, Ltd. 2013), each of which was intended to represent the novel approach of leaving some trees standing for ecological purposes rather than being retained to provide a seed source or protection for the regenerating commercial stand of trees.

Conversely, various traditional silvicultural terms have been used inappropriately to describe today's complex treatments, simply because of similarities in post-harvest spacing such as shelterwood or seed-tree, not to describe the silvicultural system. Evolving silvicultural definitions have caused confusion among foresters, other resource professionals, and the general public (O'Hara and Nagel 2013). The purpose of this discussion is to both acknowledge that terminology is an issue and to present clear definitions so that DNR uses these terms accurately and consistently.

The "silvicultural prescription" defines the timing and sequence of silvicultural activities required to attain or sustain objectives over the course of an entire rotation. A "silvicultural activity" is one of several different actions directed at assessing or controlling the harvesting, regeneration, composition, growth, structure or other attribute of a forested stand. Specific activities include site assessments, evaluations, site preparation, planting, vegetation control, thinning, and harvesting. Some activities are treatments that are applied to the forest stand to alter its developmental trajectory; these treatments are non-commercial and may include site preparation, planting, or precommercial thinning. By contrast, harvesting is a commercial treatment (or activity). Most commonly, harvesting is the cutting of trees, but harvesting may also include the removal and commercial use of alternative forest products such as boughs and mushrooms.

By definition, the "silvicultural regime" is the specific sequence of activities defined in the prescription. DNR has developed informational pamphlets describing typical regimes for both westside and eastside forests. These regimes are based on site capabilities to inform foresters about potential activities that lead to the specific outcomes associated with DNR's objectives. DNR has also published procedures and other guidance that describe the required elements of a silvicultural prescription (PR 14-005-060; PR 14-005-010). In this forest land plan, silvicultural regimes are represented from a simplified perspective of harvest method and rotation length only.

Silvicultural regimes are sometimes grouped into "silvicultural systems" 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 method (SAF 2013). These major types of silvicultural systems were further divided into groups such as clearcut, seed tree, and selection systems to provide a general description of the growing environment intended for regeneration and subsequent stand development. However, none of these definitions are a true representation of today's practices.

Due to mounting confusion over silvicultural terms and their deviation from traditional applications, DNR has adopted the term "cohort management" to describe the silvicultural system it employs. Cohorts are portions, or attributes, of a forest stand that can be defined and managed for, such as large live legacy trees, discrete age classes, or amounts of down wood. Cohort management emphasizes the retention of identifiable and difficult-to-create stand attributes (or cohorts), such as large structurally unique trees, that can be quantified and intentionally managed for while simultaneously managing the commercial tree cohort.

As the complexity of treatments has increased, the old terminology for harvests has been largely abandoned for more encompassing, but less discrete terms such as those we use today, including variable retention harvests and variable density thinning. These terms are discussed later in this chapter.

Silvicultural Prescriptions and Cohort Management

In the following section, DNR describes how it will prepare silvicultural prescriptions. DNR will also describe cohort management and the two harvest methods that are modeled in the forest estate model (variable density thinning, and variable retention harvest).

DNR's Silvicultural Prescriptions

DNR has explicitly defined its silvicultural prescription protocol and made it a required element of the timber sale process. DNR foresters are responsible for preparing a silvicultural prescription even when the potential harvest unit is originally selected by the forest estate model. Foresters may modify the potential harvest units provided by the forest estate model based on their understanding of how trees and stands grow in response to growing space and time. That understanding is enhanced by output from the forest estate model, but is ultimately a product of the forester's silvicultural knowledge and professional judgment of how different activities yield different stand conditions, or outcomes for a specific forest stand.

In DNR's cohort's management system (which will be described later in this section), a rotation for the commercial cohort is the period between regeneration and final harvest. In a final harvest, the commercial cohort trees are removed from the FMU, while other trees are retained on site as other cohorts, for example the legacy tree cohort. Within the silvicultural prescription, each activity is accompanied by defined threshold targets that signify the successful attainment of objectives for that activity.

Due to DNR's efforts to accomplish multiple objectives, which include the retention of legacy trees and other important stand attributes, within-stand factors that influence tree growth have become more intricate. In addition, the shape of harvested units has become more complex because of greater levels of forest retention due to old growth harvest deferrals, northern spotted habitat, protection of potentially unstable slopes, riparian management zones, and other reasons.

In the past, clearcuts provided a predictably competition-free environment for regeneration, providing greater certainty in meeting performance expectations. Now, regenerating trees are exposed to variable levels of competition from trees retained both within and outside of the harvest unit. Both types of competition need to be considered when developing a prescription.

In the forest estate model, within-stand competition between individual trees is accounted for in the Forest Vegetation Simulator (FVS) growth model. FVS is used to generate the yield tables that represent the growth dynamics and yields of a forest stand. Competition created by harvest unit boundaries is modeled by adjusting FVS yields with an adjustment factor for the edge density of each stand (for more information on the forest estate model, refer to Appendix D of the RDEIS). The actual silvicultural decisions related to controlling competing vegetation are simplified in the model through the use of edge density adjustments rather than having the model represent expected outcomes associated with competition control or the lack of it.

Cohort Management and Timber Harvesting

When a silvicultural prescription calls for treatments in mature stands, these treatments will almost always be commercial and involve timber harvesting. Mature stands can exist in any of the stand development stages except for Ecosystem Initiation and the small-stem phase of Competitive Exclusion. However, mature stands are generally in the pole phase of Competitive Exclusion and more complex stages. Harvest treatments may have an objective to move a stand toward one or another stand development stage, or to attempt to prolong the duration of specified conditions. Silvicultural considerations at this time may call for treatments that change stand density, species composition, and horizontal and vertical diversity in order to meet objectives.

As mentioned previously, DNR has adopted the term "cohort management" to describe the silvicultural system it employs. Cohort management evolved in response to the increasingly complex suite of objectives desired from the forests of the OESF and elsewhere. With cohort management and for this draft forest land plan, DNR uses the terms variable retention harvest and variable density thinning to describe the harvest methods modeled by the forest estate model. During actual implementation of the plan, foresters will use a wide range of harvest methods to accomplish the plan's objectives (a full list of harvest methods is provided later in Table A-15 inside Text Box A-10). Both of these harvest methods are based on the retention of structural elements or biological legacies (cohorts) to accomplish ecological objectives. Often, these retained cohorts are slow to develop or are relatively rare on the landscape.

Variable retention harvest and variable density thinning are harvest methods, not silvicultural systems, since these terms describe a single entry into the stand focused on both cutting trees and identifying important cohorts for retention or enhancement. Although some ambiguity exists between variable retention harvest and variable density thinning, for DNR the primary difference between the two is whether regeneration of a commercial cohort is planned and managed for following the harvest activity (as with a variable retention harvest) or not (as with a variable density thinning).

Through variable retention harvest and variable density thinning, DNR intentionally identifies and manages more stand cohorts than just the commercial cohort. Thus, cohort management fundamentally creates or maintains much more within-stand structural complexity than do traditional systems and harvest methods. In the following section, DNR provides more information on these two harvest methods.

Variable Density Thinning

Thinning involves selective removal of trees from a forest stand to reduce stand density and achieve stated objectives. The primary objective for thinning is to redistribute growth from trees that do not contribute to objectives, to those that do. Essentially, 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).

A variable density thinning (refer to Text Box A-9) 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 what research indicates are characteristics of stand-level heterogeneity that 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, trees sizes, species, and shapes. Knowing how trees respond to growing space allows the forester to target specific 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 (refer to Text Box A-9) 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 across the 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 maybe as large as 5 acres,[1] but more typically, will range from ¼ to 1 acre. 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 within the unit 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.

Typically, a variable density thinning is chosen over a conventional (uniform) thinning to increase within-stand structural diversity. Some conservation objectives are better met by the non-uniform stand conditions created through variable density thinning. For example, complex stand structure, including large live and dead trees, multiple canopy layers, and down wood, provides potential habitat for a wide variety of wildlife.

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. Thus variable density thinning is a valuable tool for integrating revenue production and ecological values.

Text Box A-9. Harvest Methods Used in the OESF

Variable Retention Harvest

Variable retention harvests are stand-replacement harvests in which “leave trees” (trees that are not harvested), snags, large logs, and other structural features are retained between one harvest and the next. These features provide the structural complexity across the landscape that is increasingly being recognized as important for biodiversity (Lindenmayer and Franklin 2002). Variable retention harvests are distinctly different from “clearcuts,” in which most or all of the existing forest is removed. Clearcuts leave little or no structural diversity (Franklin and others 2002). In the forest estate model, DNR classifies variable retention harvests by edge density.


Variable retention harvest with low edge density

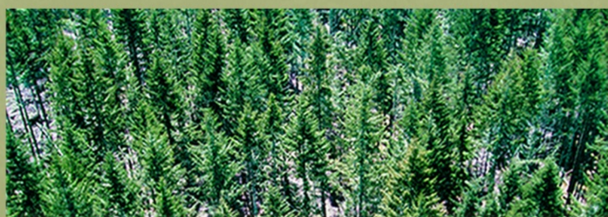

Variable retention harvest with medium edge density


Variable retention harvest with high edge density

Thinning

Thinning is normally done to reduce stand density and allow the remaining trees to become larger. In uniform thinning, trees are evenly removed throughout the stand. In variable density thinning, thinning is conducted to differing residual densities across the stand and should include a mixture of skips and gaps intended to enhance structural diversity. Skips are areas that are not thinned. Gaps are small areas where all or most of the trees are removed. The stand matrix may be thinned to a higher or lower level depending on objectives such as future thinnings or the intention for final harvest.


Variable density thinning


Uniform thinning

Variable Retention Harvest

Variable retention harvest (refer to Text Box A-9) 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). As described by Franklin and others (1997), the purpose of retaining key structural elements is to:

- "Life-boat" species and processes immediately after harvest and before forest cover is re-established,
- Enrich the re-established forest stands with structural features that would otherwise be absent, and
- Enhance connectivity in the managed landscape.

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 allow 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.

The within-stand growing environment for trees regenerating after a variable retention harvest will resemble an even-aged plantation, with levels of competition from within-stand cohorts. However, because key structural elements are retained, there is more within-stand competition with a variable retention harvest than with a clearcut. Depending on the level of retention and the edge density, competition from adjacent over story trees in the immediate growing environment around the seedling can range from virtually none (similar to a clearcut) to a high level of competition (similar to a multi-aged stand).

In the forest estate model, variable retention harvests are modeled to reflect the amount of forest edge that is likely to be created in relation to harvest opening size. In general, openings with high edge density are likely to have high levels of competition from adjacent stands that will negatively affect regeneration. Under these conditions, DNR no longer assumes the same growth rates as would occur with lower competitive levels. Another modeling assumption is that areas with the highest edge density will regenerate naturally.

In some cases, or when viewed from a larger spatial scale, a series of variable retention harvests may resemble a group selection, uneven-aged silvicultural system. However, the intent of these more traditional silvicultural systems differs from DNR's cohort management system in terms of objectives, spatial scales, and regeneration performance. Under cohort management, the appropriate mix of stand densities, openings, and leave trees is determined on a site-specific basis and depends on the objectives identified for the FMU.

Variable retention harvest is intended to enhance and protect within-stand diversity and is compatible with DNR's management strategies and objectives, which include the following:

- The riparian conservation strategy, which is designed to retain forests within wetlands, along streams, and on potentially unstable slopes associated with streams to enhance riparian function;

- The northern spotted owl conservation strategy, which is designed to retain forest structures important for the northern spotted owl and its key prey species, the northern flying squirrel;
- Current protections for marbled murrelets as expressed in the "Memorandum for Marbled Murrelet Management Within the Olympic Experimental State Forest," dated March 7, 2013, until the long-term Marbled Murrelet Conservation Strategy has been completed and adopted, and
- The multispecies conservation strategy, which provides a diverse array of habitat conditions to support multispecies goals through measurable objectives for northern spotted owls, marbled murrelets, riparian areas, and revenue production, and through protection of old growth stands and unique features on the landscape.

Refer to Chapter 2 for more information on riparian, northern spotted owl, marbled murrelet, and multispecies goals, measurable objectives, and strategies.

Modeling Silvicultural Regimes and Treatments

The art and science of silviculture is implemented through the silvicultural prescription, which describes the silvicultural regime. In general, and as stated earlier in this chapter, the term silvicultural regime describes the specific sequence of activities defined in the silvicultural prescription that will best accomplish objectives over the life of the stand.

However, in this document (and as modeled), regime is a simplified term that refers to harvest method and rotation length only. Other elements of a regime, such as regeneration method, species to be planted, densities, site preparation treatments and other vegetation control activities, and precommercial thinning, are implied. For example, a silvicultural regime may include a variable density thinning at 30 years of age and a variable retention harvest 60 years of age; it is assumed that the entire suite of regeneration activities will occur as needed.

Adjustments to Timber Volume Yields

All DNR silviculture falls within the cohort management silvicultural system, which can result in complex stand conditions that are challenging to model. To reflect the complex interactions between forest edges and forest growth, DNR has developed a set of specific adjustments to account for these effects on timber yields. Following is a description of the assumptions used to construct and interpret the outputs of the forest estate model, and of the adjustments made to the FVS-projected timber yields.

Edge Density

During the development of the forest estate model for the OESF, DNR recognized that in certain landscapes, variable retention harvests were likely to create complex forest openings with significant amounts of forest edge. Because of the potentially large effects of edge on forest growth, DNR needed a means to represent this influence on the modeled timber volume yields in the forest estate model.

To accomplish this, DNR calculated the edge density of each potential harvest unit in the model. Edge density is the ratio between the length of the potential harvest unit polygon's boundary and its area. A potential harvest unit polygon is defined using a GIS process that overlays forester-defined FMUs from P&T onto mapped harvest deferrals and land areas that are assumed to retain permanent forest cover, such as wetlands and riparian areas. When forester-defined FMUs are not available, a potential harvest unit is defined using DNR's forest inventory units (for more information, refer to Appendix D of the OESF RDEIS). For simplicity, DNR has created two categories of edge density: low to moderate (less than or equal to 523 feet per acre) and moderate to high (524 feet per acre or greater).

Potential harvest units with low edge density tend to be simpler in shape and have larger openings than potential harvest units with high edge density. DNR found that the majority of the forest (60 percent) consists of potential harvest units with low to moderate edge densities (refer to Table A-12). These potential harvest units are expected to have opening sizes of 20 acres or greater. Approximately forty percent of the forest consists of potential harvest units with moderate to high edge densities; these units have potential harvest openings size of 20 acres or less (refer to Table A-12).

Table A-12. Distribution of Potential Harvest Opening Size and Edge Density

Acres include both operable and deferred areas

		Low to moderate edge density (less than or equal to 523 feet per acre)	**Moderate to high edge density** (524 feet per acre or greater)	**TOTAL**
Potential harvest opening size	0-20 acres	458 (14,213 ac)	1,520 (87,373 ac)	1,978 (101,585 ac)
	20+ acres	1,822 (135,741 ac)	230 (20,240 ac)	2,052 (155,980 ac)
TOTAL		2280 (149,953 ac)	1,750 (107,612 ac)	4,030 (257,566 ac)

Edge Density Adjustment Factors

FVS is used to develop the individual stand-level projections that are included in the OESF forest estate model. FVS is a distance-independent, stand growth-and-yield model that forecasts only within-stand conditions. As mentioned previously, in FVS DNR accounts for within-stand competition by applying an edge density adjustment factor to each FMU. Table A-13 provides a summary of these adjustments factors.

Table A-13. Classification Of Edge Density, Expected Opening Sizes, Retention Levels And Timber Volume Adjustments Factors Used In The Modeling Process

Edge density	Exposed crown edge density (feet per acre)	Equivalent group/gap scale (acres)[1]	Equivalent opening width (feet)	Equivalent dispersed retention and desired future condition (trees per acre)[2,3]	Equivalent dispersed retention (%)	Potential western hemlock timber volume adjustment factor
Low to moderate	< 331	> 5	> 526.5	< 5	< 5	0.83 - 0.91
	331 - 523	2 – 5	333 - 526.5	5 – 8	5 – 7	0.73 - 0.83
Moderate to high	524 – 1103	1/2 – 2	166 – 333	8 – 17	7 – 15	0.43 - 0.73
	1103 – 2340	1/10 - 1/2	74.5 – 166	17 – 35	15 – 40	< 0.43
	> 2340	< 1/10	< 74.5	> 35	40+	< 0.43

[1] geometric model based on a circle
[2.] @ 11.5 dbh ~ 21 ft. crown width at time of first entry
[3.] @ 30"+ dbh ~ 33 ft. crown width (~50% capacity)

DNR assumes that potential harvest units with high edge density will experience higher variability in competition and growing conditions, which may result in the development of multiple, distinct cohorts. In stands with small opening sizes and high edge density, DNR is likely to use natural regeneration because of the abundance of potential seed sources of desirable tree species, the high level of competition due to retained trees, or the difficulty of applying a site preparation treatment, although depending on objectives, planting may be prescribed by the forester.

Projected Timber Volumes

To calculate timber volumes, DNR multiplies a potential harvest unit’s modeled volumes (modeled volumes are based on a stand growing in open conditions) by the edge density adjustment factor described in the preceding section. For example, using Table A-13, for an potential harvest unit with an edge density that falls between 1,103 to 2,340 feet per acre, DNR multiplies that potential harvest unit’s modeled volume by an adjustment factor of 0.43 to forecast the timber volume. Stated another way, the timber volume of western hemlock in an FMU with an edge density between 1,103 to 2,340 feet per acre would be only 43 percent of the modeled volume of an open-grown stand of the same age. This lower volume is logical, because trees growing in a stand with high edge density receive less sunlight than trees growing in an open environment, due to shading from the retained trees adjacent to the small opening and below- ground competition for moisture and nutrients. Such trees would grow more slowly and have lower volumes than would trees grown without competition.

Silvicultural Regimes and Treatments

Table A-14 summarizes the silvicultural regimes and treatments that may be used in the OESF. These sequences of treatments are not prescribed, but are shown to demonstrate the kinds of silvicultural activities a forester is likely to consider. When developing a silvicultural prescription for an FMU, DNR foresters consider multiple factors that can influence the progression towards accomplishing objectives.

For example, a stand with poor stocking is unlikely to require precommercial thinning as compared to a stand with a high level of stocking. Usually, the forester conducts periodic evaluations to determine the need for intervention in actively growing and established stands.

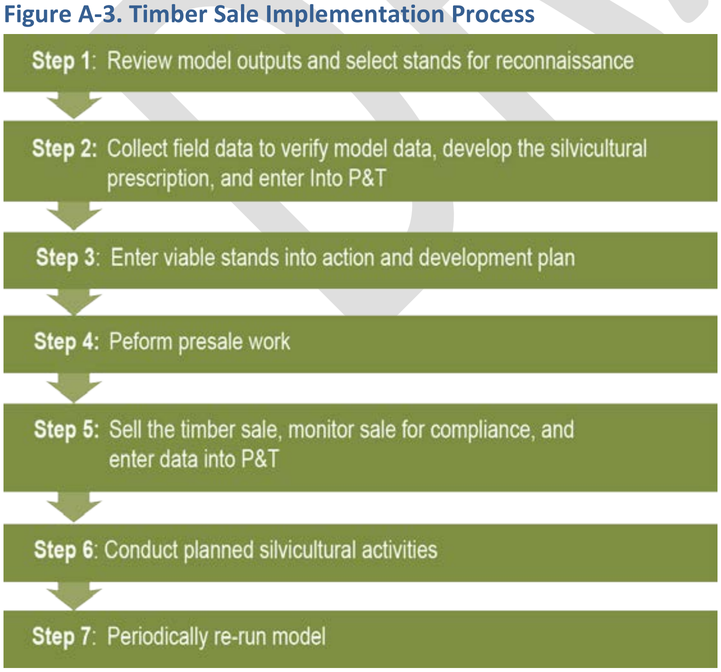
Table A-14. Summary of Modeled Silvicultural Treatments and Regimes
Years listed in table are approximate

		Silvicultural regimes					
		40-year rotation	50-year Rotation	60-year Rotation	70-year Rotation	80+ year Rotation	Thinning regime
Silvicultural treatment	Re-establishment	Planting	Planting	Planting	Planting	Planting	Natural
	Vegetation management	Once or twice: site preparation prior to planting or at a later date as a release treatment (generally years 1-8)					n/a
	Pre –commercial thinning	If applied shortly after the site becomes fully occupied with trees (site dependent but generally between year 12 and 20)					n/a
	1st thinning	n/a	In years 30 to 40				In year 30
	2nd thinning	n/a	n/a	n/a	In years 60 to 70		In year 60
	3rd thinning	n/a	n/a	n/a	n/a	In year 90	In year 90
	End of rotation harvest	In years 35-45	In years 45-55	In years 55-65	In years 65-75	In years Greater than 75	May or may not be rotated

Timber Sale Implementation Process

This section describes the steps in the timber sale implementation process, as illustrated in Figure A-3.

Figure A-3. Timber Sale Implementation Process



Step One: Review Model Outputs and Select Stands for Reconnaissance

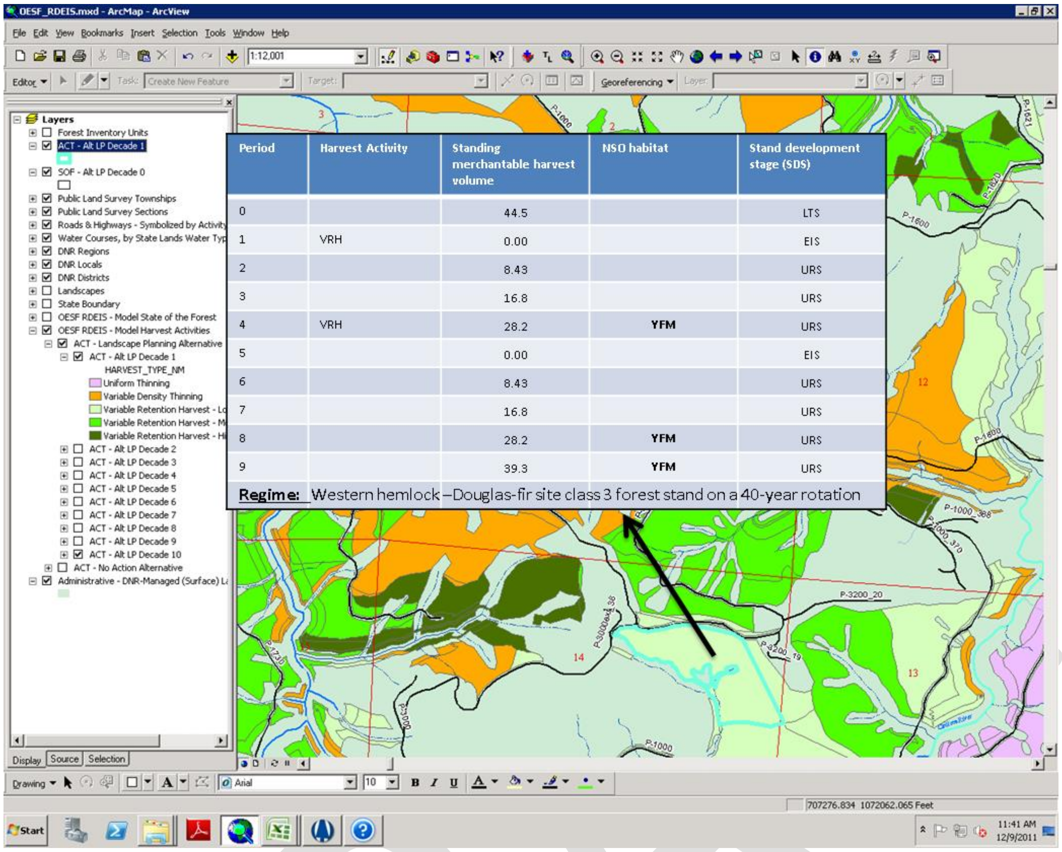
In this step, foresters use the harvest schedule to review the locations of modeled harvests in current and future decades and select potential timber sale areas for field reconnaissance.

The harvest schedule is output into a geo-database known as the "activities file" to provide spatial results. The activities file reports harvests in ten-year intervals. Each decade in the activities file is a report of harvests scheduled for the next ten years. For example, decade 1 harvests will occur at some point in time between today (the date of the last model run) and the start of the next decade.

Like the harvest schedule, the detailed report of site-specific future forest conditions also is output into a geo-database to provide spatial results. This geo-database is known as the "state of the forest file." The state of the forest file reports conditions at a moment in time; in other words, it is a "snapshot" of the forest at the start of the given decade. Decade 0 is a report of current conditions; decade 1 is a report of projected conditions 10 years later; decade 2, 20 years later; and so on.

Information from the forest estate model may be combined with data and information from other models such as the northern spotted owl stand-level model and riparian indicator models developed for the OESF RDEIS analysis (refer to Appendix I and G of the RDEIS, respectively), the windthrow probability model, and DNR'S corporate GIS data. All data can be displayed in GIS software or in tabular form. Using the GIS software (refer to Figure A-4), foresters will be able to click on a spatial unit to bring up tabular information about that unit, including timber volume, stand development stage, and whether or not that location is projected to contribute to northern spotted owl habitat thresholds. GIS software also includes the location and stream type data for mapped streams, and the location of roads, unstable slopes, and other features that may influence the size, location, or configuration of a potential harvest unit. Using this information, the forester can make preliminary decisions about including a potential harvest unit in an individual timber sale. Considerations on sale location may include volume targets for the potential harvest unit, timber value, access to the site including road conditions, and habitat conservation objectives.

Figure A-4. Screen Shot of GIS Software



Step Two: Collect Field Data to Verify Model Data, Develop the Silvicultural Prescription, and Enter Into P&T

Foresters visit the potential harvest units chosen by the model to perform field reconnaissance to see if the potential harvest units are a viable option for inclusion in a timber sale. Foresters evaluate the condition of the forest roads that accesses the site to ensure road conditions meet current forest practices rules with an emphasis on identifying areas that could deliver sediment to streams from the roads. At the potential harvest unit, the forester verifies whether the stand conditions, volume of wood, and operability of the ground are similar to the information reviewed in Step 1.

Field reconnaissance may indicate a potential harvest unit does not meet silvicultural objectives, is not viable as a timber sale, or both. For example, trees may be in an incorrect age class or incorrect volume or crown closure, or the stand may have grown faster or slower than expectations. In addition, the potential harvest unit may contain unmapped or mistyped streams, or a large portion of the area may contain non-merchantable timber due to site class. In some cases, the cost of road building or harvesting may be too high.

If a potential harvest unit is considered viable, the forester will collect reconnaissance-level data. Specifically, the forester will map and type streams, estimate timber volume, document any roads, and identify potential unstable slopes and any other features found.

Once field data is collected from the site, silvicultural and activity prescriptions will be developed and entered into P&T (refer to Text Box A-10). At this time, foresters will delineate an FMU in P&T. Data from P&T also is used for budget planning purposes. For example, precommercial thinning budgets are based on expected levels of precommercial thinning indicated in P&T.

P&T is used to periodically update the information in the forest estate model. Information collected on the ground, such as stream typing information, will also be used to update the forest estate model.

Text Box A-10. P&T

DNR records planned and implemented harvest activities in P&T. This database contains a variety of timber harvest methods that DNR implements on forested state trust lands. Table A-15 shows the different timber harvest methods contained in P&T and how they relate to either variable density thinning and/or variable retention harvest.

Table A-15. OESF Silvicultural Treatments and DNR Timber Harvest Types

OESF silvicultural treatment	DNR timber harvest types	
Variable density thinning	Commercial thinning	Two-aged management–westside[1]
	Selective product logging	Variable density thinning
Variable retention harvest	Variable retention harvest	Late rotation thinning
	Uneven-aged management	Temporary retention first cut
	Shelterwood intermediate cut	Temporary retention removal cut
	Shelterwood removal cut	Clearcut
	Seed tree intermediate cut	Phased patch regeneration cut
	Seed tree removal cut	Two-aged management– westside[1]

[1] Placement in an OESF silvicultural treatment category depends on the amount of removal.

Step Three: Enter Viable Stands Into Action and Development Plan

Potential timber sales that are considered viable are entered into the Olympic region's action and development plan. An action and development plan is the primary planning tool used to develop the timber harvest budget and project future income. The plan consists of "action" sales that are in the planning stages for taking to market within the next two years, and "development" sales that will be ready for market within the next three to five years.

The goal is to enter one to two years' worth of timber sales into the plan so the unit forester can allocate the correct staffing resources. Having one to two years of timber sales in the action and development plan helps maximize workflow efficiencies, reduce uncertainties as timber harvests are set up, and ensures a steady flow of timber sales volume.

Step Four: Perform Presale Work

The presale work consists of laying out the timber sale on the ground and completing all of the paperwork documenting the sale. Presale work entails numerous steps and personnel.

On-the-ground presale work includes tagging (marking) the boundary of the timber sale; locating and verifying stream types, roads, landings and/or wetland types; identifying potentially unstable slopes; identifying and marking applicable interior core buffers; marking leave trees; and cruising the merchantable timber. Generally, this work is done by foresters from the Olympic region. When necessary, foresters from the Olympic region consult with specialists such as geologists, biologists, or archeologists. Presale work also includes determining the logging method that will be used, such as ground-based or cable logging. Engineers help design roads associated with the timber sale as needed.

Presale work also includes preparing items for the presales packet that documents the proposed timber sale and posting them to the timber sale document center on DNR’s intranet. These items include:

- Driving instructions and a vicinity map that details the area surrounding the timber sale;
- A logging plan map which shows the location of the timber sale, the timber sale unit boundaries, leave tree areas in each unit, streams, roads, and the harvest and logging methods to be used in each unit;
- A special concerns report that documents sensitive elements of the environments such as drinking water sources, cultural resources, and protected wildlife species;
- A draft timber sale contract;
- A road plan;
- A completed State Environmental Policy Act (SEPA) checklist and threshold determination;
- A completed 1997 HCP checklist; and
- A completed forest practices application.

Specialists such as geologists or biologists may visit the proposed sale and write reports that will also be included in the presale packet.

Step Five: Sell the Timber Sale, Monitor Sale for Compliance, and Enter Data Into P&T

DNR conducts three types of timber sales: lump sum, scale, or contract harvest. In a lump sum sale, the buyer purchases all of the merchantable timber within the timber sale for the price bid at auction. The purchaser is responsible for harvesting the timber in accordance with the silvicultural prescription in the contract.

In a scale sale, the purchaser harvests the merchantable timber within the timber sale according to the silvicultural prescription in the contract. The harvested timber is measured by scale (board feet or cubic feet) or by weight (typically tons). The buyer only pays for the merchantable timber removed.

In a contract harvest, DNR hires a harvest contractor to harvest the merchantable timber. DNR sells the harvested logs to different buyers. The harvest contractor transports the logs from the harvest unit(s) to the mills and log-sort locations of the various log purchases.

If the total value of the sale is above a certain amount specified in RCW 79.11.130, the region must obtain approval of the minimum bid price from the Board of Natural Resources. DNR calls these sales "Board sales." If the total value of the sale is below a certain amount, this approval is not necessary; DNR calls these sales "region sales."

After timber sales are sold, they are generally harvested within two to four years. Regardless of the type of timber sale (lump sum, scale, or contract harvest), DNR will conduct compliance monitoring during harvest. Compliance monitoring is done to make sure whoever is harvesting the timber is following the timber sale contract, complying with applicable state and federal laws such as the Forest Practices Act and the Endangered Species Act, and meeting DNR policies. DNR may check leave trees, interior-core buffers, wetland buffers, harvest methods, and other contract items for contract compliance.

Step Six: Conduct Planned Silvicultural Activities

The silvicultural prescription identifies the activities required for the stand to perform according to expectations and remain on the necessary trajectory to accomplish stated objectives. If required by the silvicultural prescription, DNR regenerates the FMU after harvest.

DNR can regenerate FMUs by planting with seedlings grown at DNR's Webster Nursery in Olympia. Foresters determine the number, stock type, and species composition of seedlings by considering site conditions, such as edge density, and the FMU's management objectives. The area may also be reseeded through natural regeneration if the edge density is high. Often, the prescription calls for a site preparation treatment ahead of the planting effort to reduce vegetative competition.

DNR foresters periodically monitor the regenerated stand as it grows. Foresters document seedling survival and growth and determine if vegetation management is needed, for instance, if vegetation is out-competing the young trees for site nutrients and moisture. DNR generally uses herbicides for vegetation management but may also use hand slashing of competing woody vegetation when conditions warrant. DNR also monitors the stand to assess the need for precommercial thinning to reduce competition between young trees, which maximizes future options for the stand for revenue production or for meeting 1997 HCP habitat thresholds. The timing of monitoring efforts designed to track stand development should be identified in the prescription.

New information on planting, vegetation management, precommercial thinning, commercial thinning, or regeneration harvest is recorded in P&T as these activities occur.

Step Seven: Periodically Re-run Model

As mentioned earlier in this chapter, DNR expects to re-run the forest estate model periodically to reflect updated information. When the model is re-run, DNR will output new or updated activities and state of the forest files and other associated information.

Modeling Results

In the following section, DNR discusses the results of the model in terms of the operable and actively managed forest area, the number of acres of state trust lands modeled under each silvicultural regime, the number of acres of state trust lands modeled under each regime in each of the 11 landscapes, harvest volumes and revenues, and riparian and northern spotted owl habitat.

Operable and Actively Managed Areas

The operable area is the portion of the OESF where, according to current state law, policies, procedures, and management strategies, DNR can perform timber harvest activities. The operable forest area is 146,734 acres (57 percent) of the OESF.

The forest estate model can, and usually does, assign timber harvest activities to these areas. However, the model does not assign timber harvest activities to some operable areas. Reasons may include modeling assumptions related to potentially prohibitive road costs, potentially low site productivity or assumed low commodity value, or an expectation that the best pathway to meet conservation objectives is "no management." Approximately 26,289 acres (18 percent) of the operable area is in this category. In other words, approximately 10 percent of the OESF is considered operable but does not have modeled harvest activities. Thus, the actively managed portion of the operable area, or the area scheduled by the forest estate model for harvest activities, is only 120,495 acres (82 percent) of the operable area. This amount is approximately 47 percent of state trust lands in the OESF.

The remainder of state trust lands in the OESF are in long-term deferrals. Long-term deferrals are areas that are not available for timber harvest activities due to current state law, policies, procedures, and guidelines (refer to Chapter 1). Long-term deferrals include floodplains, old-growth stands, potentially unstable slopes associated with streams, and specific wildlife habitat. The forest estate model does not assign timber harvest activities to these areas. At this time, long-term deferrals account for 110,823 acres, or 43 percent of the OESF.

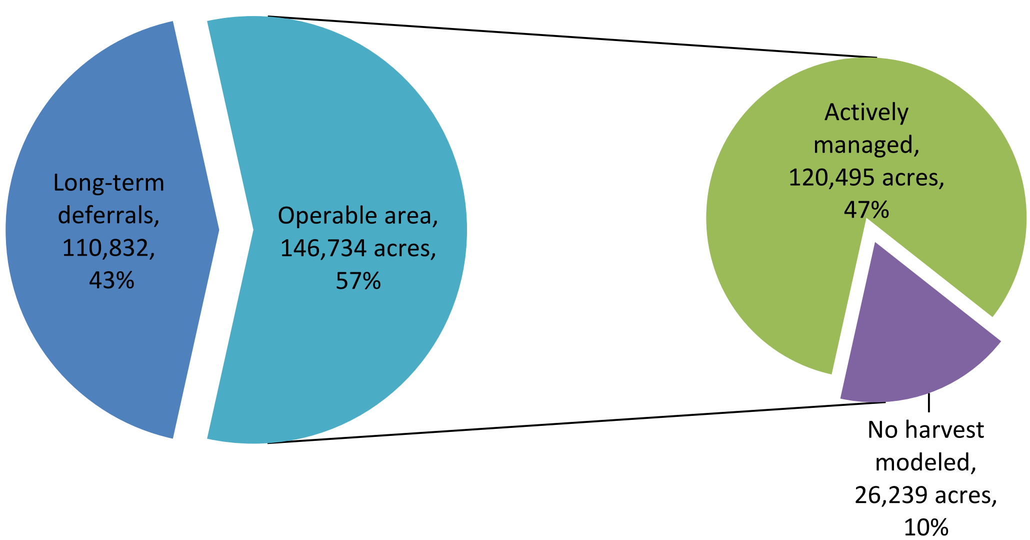
Table A-16 shows the breakdown in the forest estate model between areas that are actively managed (operable and scheduled for timber harvest activities), areas that are operable but where no timber harvest was modeled, and areas that are long-term deferrals (not operable, not scheduled for timber harvest activities). Chart A-2 shows the breakdown for all state trust lands in the OESF.

Table A-16. Operable Area (Actively Managed and No Management Expected) and Long-Term Deferrals on State Trust Lands in the OESF, in Acres, by Landscape

	Operable area						
	Actively managed		No harvest modeled		Long-term deferrals		
Landscapes	Acres	Percent of total landscape acres	Acres	Percent of total landscape acres	Acres	Percent of total landscape acres	TOTAL ACRES
Clallam	12,915	75%	677	4%	3,684	21%	17,276
Clearwater	19,312	35%	3,712	7%	32,179	58%	55,203
Coppermine	7,593	39%	2,653	14%	9,000	47%	19,246
Dickodochtedar	16,361	58%	3,392	12%	8,294	30%	28,047
Goodman	13,252	56%	784	3%	9,763	41%	23,799
Kalaloch	6,751	37%	3,398	19%	7,973	44%	18,122

Landscapes	Operable area: Actively managed Acres	Actively managed Percent of total landscape acres	No harvest modeled Acres	No harvest modeled Percent of total landscape acres	Long-term deferrals Acres	Long-term deferrals Percent of total landscape acres	TOTAL ACRES
Queets	8,459	41%	3,102	15%	9,245	44%	20,807
Reade Hill	3,856	45%	227	3%	4,396	52%	8,479
Sekiu	6,388	64%	1,822	18%	1,804	18%	10,014
Sol Duc	12,692	66%	673	4%	5,781	30%	19,146
Willy Huel	12,918	35%	5,796	15%	18,714	50%	37,428
TOTAL ACRES	120,495	47%	26,239	10%	110,832	43%	257,566

Chart A-2. Operable Area and Long-Term Deferrals on State Trust Lands in the OESF



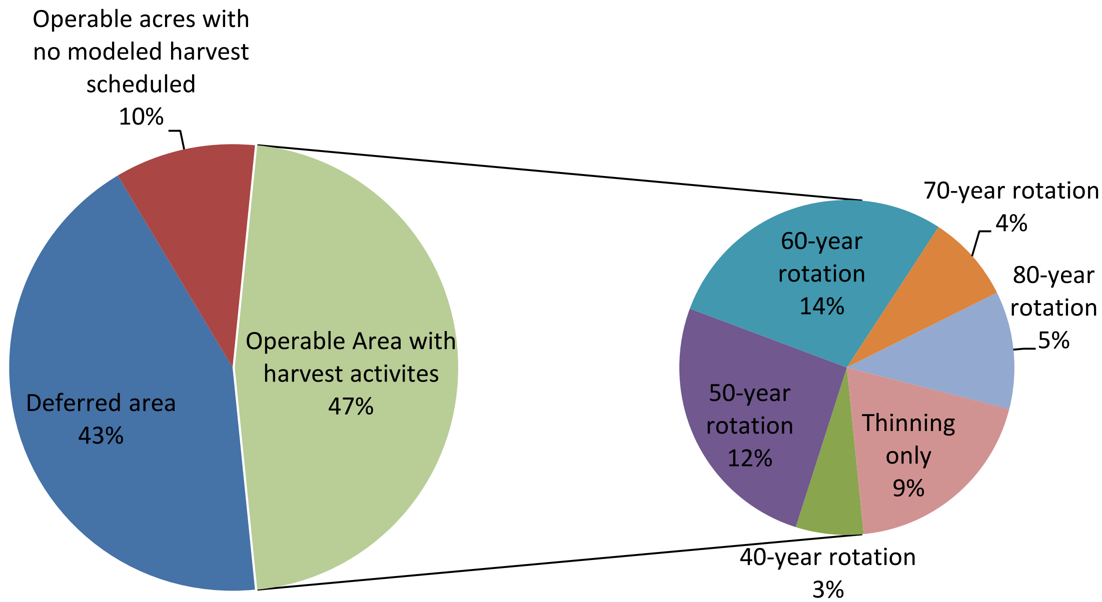
How Many Acres of the OESF Are Modeled Under Each Silvicultural Regime?

Table A-17 shows the number of acres (and the corresponding percentages) of state trust lands in the OESF that DNR has modeled under each silvicultural regime. Chart A-3 shows the same information graphically. All actively managed areas will be managed under the cohort management system. Per model projections, approximately 37 percent of state trust lands in the OESF will be managed with a specified rotation length, and approximately 9 percent will be managed with thinning only. The rest of state trust lands in the OESF is projected to have little to no active harvest scheduled. Given current forest conditions, harvest deferrals, and modeling assumptions, DNR believes that the mix of regimes is the optimal way to integrate revenue production and ecological values in the OESF.

Table A-17. State Trust Lands Modeled Under Each Silvicultural Regime, By Acres and Percentage

Silvicultural regime	Acres	Percent of state trust lands in the OESF	Percent of the operable area
40-year rotation	7,872	3%	5%
50-year rotation	31,074	12%	21%
60-year rotation	34,323	13%	23%
70-year rotation	10,174	4%	7%
80-year rotation	13,687	5%	9%
Thinning only	23,365	9%	16%
Operable acres with modeled harvests scheduled	120,495	47%	82%
Operable acres with no modeled harvest scheduled	26,239	10%	18%
Subtotal: operable	146,734	57%	100%
Deferred area	110,832	43%	
TOTAL	257,566	100%	

Chart A-3. State Trust Lands Modeled Under Each Silvicultural Regime, By Percentage



How Many Acres of Each Landscape Are Projected to be Managed Under Each Silvicultural Regime?

Table A-18 shows the number of acres, and the corresponding percentages, that are projected to be managed under each silvicultural regime in each of the 11 landscapes in the OESF. The highlighted green cells in Table A-18 indicate the dominant regimes in each landscape.

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Table A-18. Forested Acres, Percent of Total Landscape Forested Area, and Percent of Operable Acres by Silvicultural Regime for Each Landscape in the OESF

Landscape	Silvicultural regime					Thinning only	Operable land, no management expected	Deferred	TOTAL
	40 year rotation	50 year rotation	60 year rotation	70 year rotation	80 year rotation				
Clallam									
Acres in landscape	743	3,392	2,674	711	3,314	2,081	677	3,684	17,276
Percent of landscape	4%	20%	15%	4%	19%	12%	4%	21%	100%
Percent of total operable area	5%	25%	20%	5%	24%	15%	5%	n/a	n/a
Clearwater									
Acres in landscape	452	4,799	5,586	1,327	1,353	5,795	3,712	32,179	55,203
Percent of landscape	1%	9%	10%	2%	2%	10%	7%	58%	100%
Percent of total operable area	2%	21%	24%	6%	6%	25%	16%	n/a	n/a
Coppermine									
Acres in landscape	1,382	1,401	2,017	637	193	1,962	2,653	9,000	19,246
Percent of landscape	7%	7%	10%	3%	1%	10%	14%	47%	100%
Percent of total operable area	13%	14%	20%	6%	2%	19%	26%	n/a	n/a
Dickodochtedar									
Acres in landscape	676	4,305	4,731	1,908	2,640	2,100	3,392	8,294	28,047

Landscape	Silvicultural regime					Thinning only	Operable land, no management expected	Deferred	TOTAL
	40 year rotation	50 year rotation	60 year rotation	70 year rotation	80 year rotation				
Percent of landscape	2%	15%	17%	7%	9%	7%	12%	30%	100%
Percent of total operable area	3%	22%	24%	10%	13%	11%	17%	n/a	n/a
Goodman									
Acres in landscape	1,652	3,319	5,221	955	941	1,165	784	9,763	23,799
Percent of landscape	7%	14%	22%	4%	4%	5%	3%	41%	100%
Percent of total operable area	12%	23%	37%	7%	7%	8%	6%	n/a	n/a
Kalaloch									
Acres in landscape	282	1,271	2,228	639	131	2,200	3,398	7,973	18,122
Percent of landscape	2%	7%	12%	4%	1%	12%	18%	44%	100%
Percent of total operable area	3%	13%	22%	6%	1%	22%	33%	n/a	n/a
Queets									
Acres in landscape	1,011	4,456	2,034	175	161	622	3,102	9,245	20,807
Percent of landscape	5%	21%	10%	1%	1%	3%	15%	44%	100%
Percent of total operable area	9%	39%	18%	1%	1%	5%	27%	n/a	n/a

Landscape	Silvicultural regime: 40 year rotation	50 year rotation	60 year rotation	70 year rotation	80 year rotation	Thinning only	Operable land, no management expected	Deferred	TOTAL
Reade Hill									
Acres in landscape	202	977	1,041	399	471	766	227	4,396	8,479
Percent of landscape	2%	12%	12%	5%	6%	9%	2%	52%	100%
Percent of total operable area	5%	24%	25%	10%	11%	19%	6%	n/a	n/a
Sekiu									
Acres in landscape	375	1,741	1,444	568	1,654	606	1,822	1,804	10,014
Percent of landscape	4%	17%	14%	6%	17%	6%	18%	18%	100%
Percent of total operable area	5%	21%	18%	7%	20%	7%	22%	n/a	n/a
Sol Duc									
Acres in landscape	682	4,255	2,803	1,324	1,823	1,787	673	5,781	19,146
Percent of landscape	4%	22%	15%	7%	10%	9%	3%	30%	100%
Percent of total operable area	5%	32%	21%	10%	14%	13%	5%	n/a	n/a
Willy Huel									
Acres in landscape	415	1,158	4,545	1,514	1,005	4,282	5,796	18,714	37,428
Percent of landscape	1%	3%	12%	4%	3%	11%	15%	50%	100%

Landscape	Silvicultural regime 40 year rotation	50 year rotation	60 year rotation	70 year rotation	80 year rotation	Thinning only	Operable land, no management expected	Deferred	TOTAL
Percent of total operable area	2%	6%	24%	8%	5%	23%	31%	n/a	n/a
OESF									
Acres in landscape	7,872	31,074	34,323	10,174	13,687	23,365	26,239	110,832	257,566
Percent of landscape	3%	12%	13%	4%	5%	9%	10%	43%	100%
Percent of total operable area	5%	21%	23%	7%	9%	16%	18%	n/a	n/a

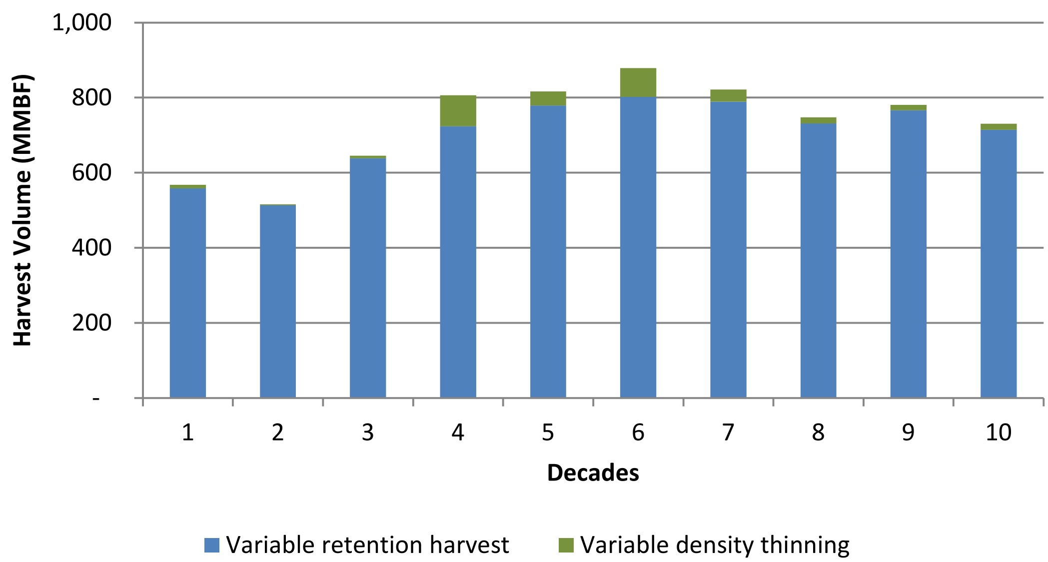
Projected Harvest Volumes and Revenues

The Board of Natural Resources periodically (on approximately a 10-year interval) sets the sustainable harvest level for all sustainable harvest units. The OESF is an independent sustainable harvest unit per DNR Policy (refer to Chapter 1). Based on the current sustainable harvest calculation,[2] the current sustainable harvest for the OESF is 576 million board feet for the decade between fiscal years 2005 and 2014, worth approximately $144 million (gross revenue). At the time of drafting this plan, the Board of Natural Resources has neither approved a sustainable harvest level for the next decade, nor adjusted the current sustainable harvest level for the OESF. DNR has made the following assumptions regarding projections of future harvest volumes and revenues for this draft forest land plan:

- The projected harvest volume is constrained by the maximum management funding level for the OESF, which is approximately $2.6 million per year (refer to "How Do Funding Levels Affect Harvest Volume?" in the following section);
- Decade 1 harvest volumes (refer to Chart A-4) approximate the current sustainable harvest level of 576 million board feet, while future harvest volumes reflect levels that are constrained by management funds; and
- Prices and management costs are held constant throughout the analysis period and reflect today's (fiscal year 2013) prices.

Chart A-4 shows the projected harvest volumes by harvest method based on these assumptions.

Chart A-4. Projected Harvest Volume by Harvest Method



How Do Funding Levels Affect Harvest Volumes?

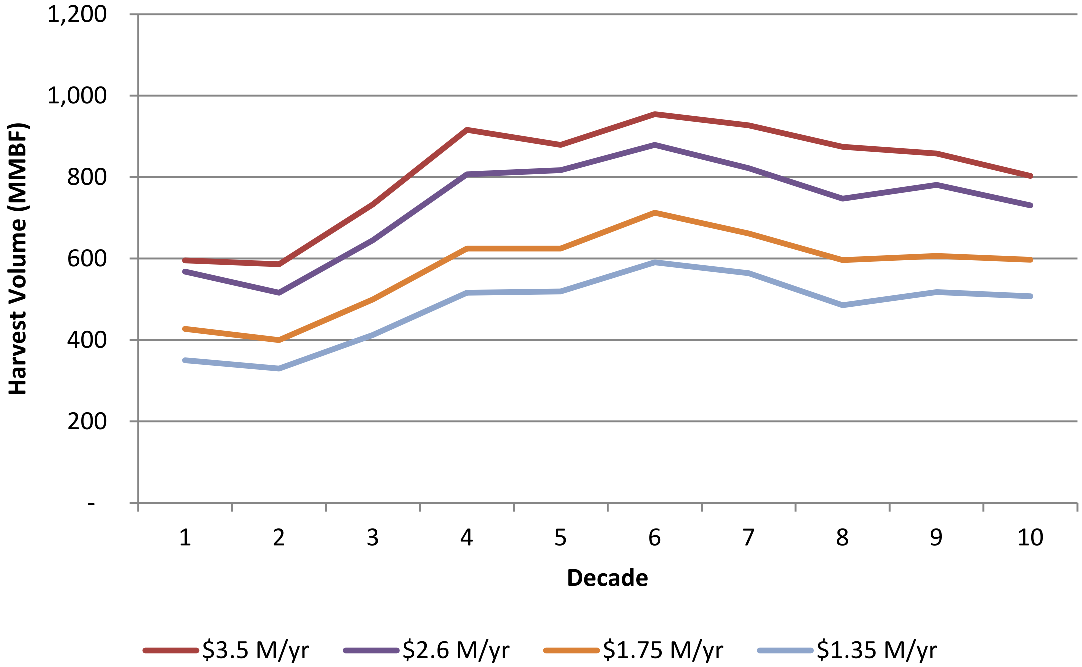
As part of a sensitivity analysis of key assumptions in the forest estate model, DNR explored how different funding levels for the OESF affect forest outcome and outputs, including harvest volumes and revenues. Each harvest activity has an associated cost in dollars per acre. Costs are also incurred when a road is used for a timber harvest. In addition, when a variable retention harvest is performed, costs are incurred for site preparation, planting, vegetation management, and precommercial thinning. In addition, there is a management cost per acre to cover administrative costs for running the region office in Forks and the main office in Olympia. Total costs are paid from management funds.

DNR found that varying the allowable management fund budget level had a significant effect on projected harvest volumes. The sensitivity analysis included four levels of funding: $2.6 million per year (reflecting the current level of funding at the time of writing this draft), $3.5 million per year (a level at which funding does not constrain harvest level), $1.75 million per year, and $1.35 million per year (representing lower funding levels that DNR has experienced in recent times). These sensitivity analyses included all other policy objectives and constraints.

Based on these funding levels, the sensitivity analysis generated a range of harvest volumes for decade 1 of the analysis period. Volumes ranged from 350 to 600 million board feet (MMBF) (refer to Chart A-5). The exact funding level for the OESF will likely vary between biennial funding cycles and decades; however, during the first decade of the analysis period, DNR assumes that funding levels will remain relatively stable and will be comparable to recent biennial funding cycles, which are equivalent to $2.6 million per year.

Chart A-5. Effect of Funding Level on Harvest Volume

The sensitivity analysis examined the effect on harvest volume production by varying a constraint on the maximum level of funding (equivalent to the dollar per year) while maintaining all other objectives and constraints constant. The funding level constraint was held constant over the analysis period of 100 years for each funding level.



Given management cost and price assumptions, this sensitivity analysis determined that a funding level of $2.6 million per year is required to approximate the level of harvest as specified under the 2007 sustainable harvest calculation. As mentioned previously, harvest volume approximates the current sustainable harvest level (fiscal year 2005 through 2014) for the OESF of 576 million board feet.

Under all funding levels analyzed, the harvest volume is projected to increase in decades 3 through 6. This increase in the harvest volume is largely a reflection of changing forest resources, particularly the growth of trees, on state trust lands in the OESF. By decade 3, the forest is projected to have a greater proportion of forest stands in a merchantable condition (older than 50 years), which will result in higher timber volume yields per acre.

Tables A-19 and A-20 include projected harvest volumes and gross revenues by trust and landscape for the first decade of the plan, based on a funding level of $2.6 million and the current sustainable harvest level of 576 million board feet for the current decade. DNR assumes that expenditures of $2.6 million per year will cover all operational costs of planting, vegetation management, precommercial thinning, timber harvest presale layout, timber sale contract compliance costs, and region administrative overhead. DNR also assumes that road building and maintenance costs are incorporated into the stumpage values received at the time of sale. The information in Tables A-19 and A-20 is intended to provide details for the projected distribution of the harvest across the OESF; it should not be interpreted as targets or policy-level commitments. The OESF is an independent sustainable harvest unit per the 2006 *Policy for Sustainable Forests;* therefore, the regulation of the harvest level by volume is conducted at the OESF scale and not by landscape or trust.

Table A-19. Projected Harvest Volume (MMBF) by Trust and Landscape During the First Decade of the Plan, Assuming a $2.6 Million Funding Level

Landscape	Agricultural-School	Capitol-Grant	Common-School-and-Indemnity	Normal-School	Scientific-School	State-Forest-Purchase	State-Forest-Transfer	University Transferred	Total
Clallam	0	7.4	6.9	0	1.2	0	76.4	0	91.9
Clearwater	0	0	39.5	0	0	0	0	0	39.5
Coppermine	0	0	24.5	3.4	0	0	0	0.7	28.7
Dickodochtedar	2.2	18.7	14.4	0	0	<0.1	25.8	0	61.1
Goodman	0	3.2	2.4	0	0	0	2.1	28.5	36.1
Kalaloch	0	6.0	26.8	1.1	0	0	0	0	33.9
Queets	0	0	8.8	1.9	0	0	0	19.1	29.8
Reade Hill	0	29.7	2.2	0.8	0	0	0.5	0	33.2
Sekiu	5.2	3.1	3.2	0	0	0	6.1	0	17.7
Sol Duc	6.3	36.1	62.6	0	1.6	0	22.3	0	128.9
Willy Huel	0	13.4	53.6	<0.1	0	0	0	0	67.1
Total	**13.8**	**117.5**	**244.9**	**7.3**	**2.9**	**<0.1**	**133.2**	**48.3**	**567.8**

Table A-20. Projected Gross Revenue[1] ($ Millions) by Trust and Landscape During the First Decade of the Plan, Assuming a $2.6 Million Funding Level

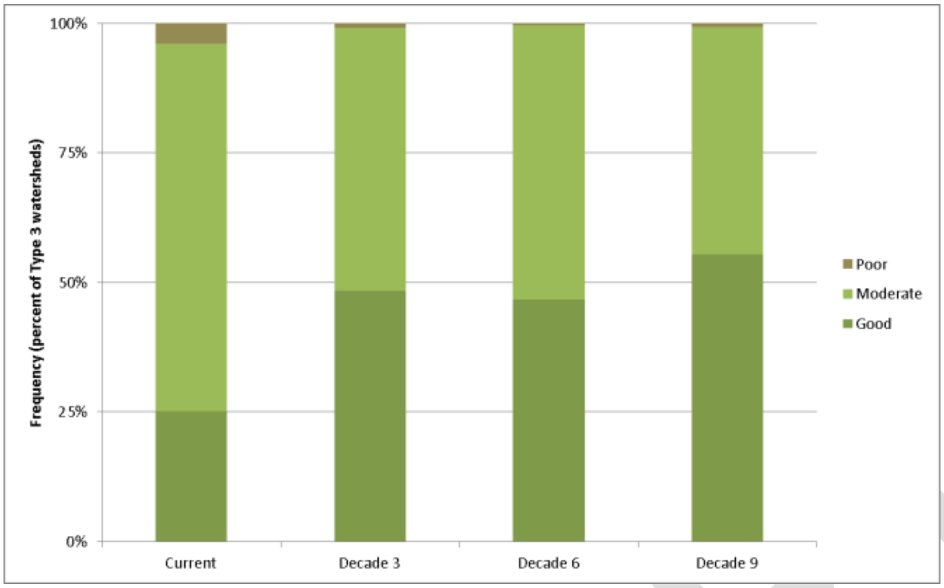
Landscape	Agricultural-School	Capitol-Grant	Common-School-and-Indemnity	Normal-School	Scientific-School	State-Forest-Purchase	State-Forest-Transfer	University Transferred	TOTAL
Clallam	0	1.5	1.2	0	0.2	0	14.8	0	17.6
Clearwater	0	0	8.1	0	0	0	0	0	8.1
Coppermine	0	0	4.8	0.6	0	0	0	0.2	5.6
Dickodochtedar	0.5	3.8	2.9	0	0	<0.1	5.1	0	12.3
Goodman	0	0.7	0.5	0	0	0	0.4	6.2	7.8
Kalaloch	0	1.2	5.6	0.2	0	0	0	0	7.1
Queets	0	0	1.9	0.4	0	0	0	4.1	6.4
Reade Hill	0	5.2	0.4	0.1	0	0	<0.1	0	5.8
Sekiu	1.0	0.7	0.6	0	0	0	1.2	0	3.5
Sol Duc	1.1	7.3	13.4	0	0.3	0	4.5	0	26.7
Willy Huel	0	2.8	11.1	0.0	0	0	0	0	13.9
TOTAL	**2.6**	**23.3**	**50.5**	**1.4**	**0.6**	**<0.1**	**26.1**	**10.4**	**114.8**

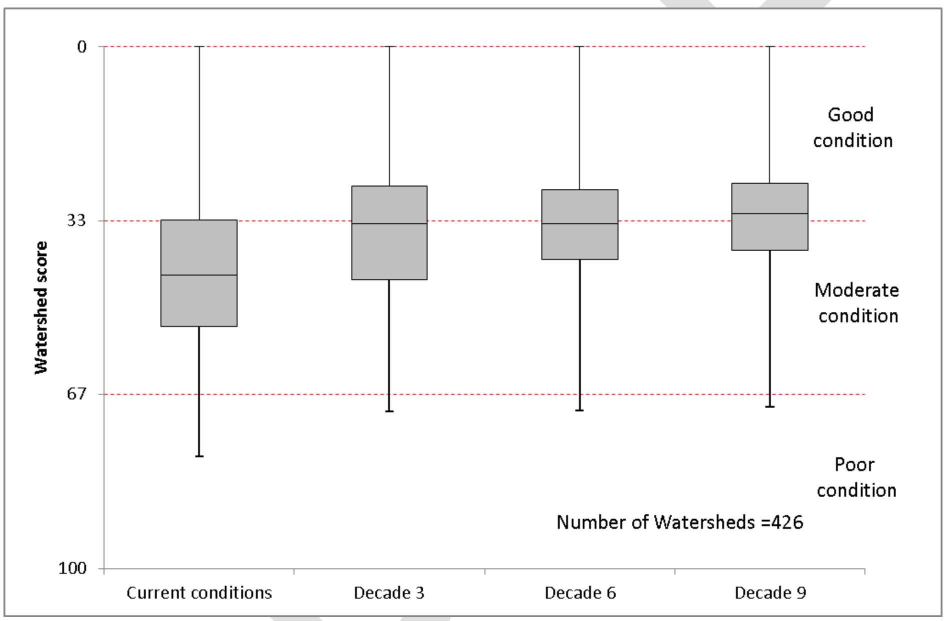
[1]Gross revenue is revenue prior to deduction of DNR management fees.

Riparian Conditions and Northern Spotted Owl Habitat

The 1997 HCP riparian and northern spotted conservation strategies are central to DNR's goals for ecological values (Chapter 2). Improvements in riparian conditions at the Type 3 watershed scale (refer to Chart A-6) reflect attainment of the goals and measurable objectives of the riparian conservation strategy (refer to Chapter 2). Watershed scores were developed for the OESF RDEIS analysis; refer to "Riparian" in Chapter 3 of that document for more information.

Chart A-6. Distribution of Projected Watershed Scores Over the 100-Year Analysis Period for All Type 3 Watersheds With Over 20-percent DNR Ownership[3]





Attainment of northern spotted owl objectives (refer to Table A-21) varies by landscape due to the differences in harvest histories and ecological conditions. Chart A-7 shows projected acres of northern spotted owl habitat on all state trust lands in the OESF, by decade. Chart A-8 and A-9 show the projected acres of northern spotted owl habitat in the riparian and upland land classifications, and Figure A-4 provides an example of how the amount of Old Forest Habitat is projected to change on state trust lands in one of the 11 landscapes in the OESF.

Across state trust lands in the OESF, northern spotted owl habitat levels are projected to increase steadily over the next 90 to 100 years. The increase in older forest conditions is a result of long-term deferrals and the implementation of the riparian conservation strategy. Under the riparian conservation strategy, DNR designates riparian management zones along streams. Riparian management zones, which consist of an interior-core buffer and an exterior buffer if needed, are areas managed to meet the measurable objectives of the riparian conservation strategy (refer to Chapter 2). During the development of the 1997 HCP, riparian management zones across the OESF were anticipated to provide up to 50 percent of northern spotted owl habitat (p. IV.106). While current projections do not indicate these levels, riparian management zones play an important role in the northern spotted strategy by providing approximately one third of Old Forest and Young Forest Habitat.

Table A-21. Decades in Which Landscapes Meet Northern Spotted Owl Habitat Thresholds

Landscape	Decade in which the 20 percent Old Forest Habitat threshold is met	Decade in which the 40 percent Young Forest Habitat and better threshold is met
Clallam	5	1
Clearwater	0	5
Coppermine	7	6
Dickodochtedar	4	2
Goodman	0	3
Kalaloch	5	4
Queets	0	4
Reade Hill	0	1
Sekiu	6	5
Sol Duc	8	2
Willy Huel	0	6

Chart A-7. Projected Northern Spotted Owl Habitat on State Trust Lands in the OESF

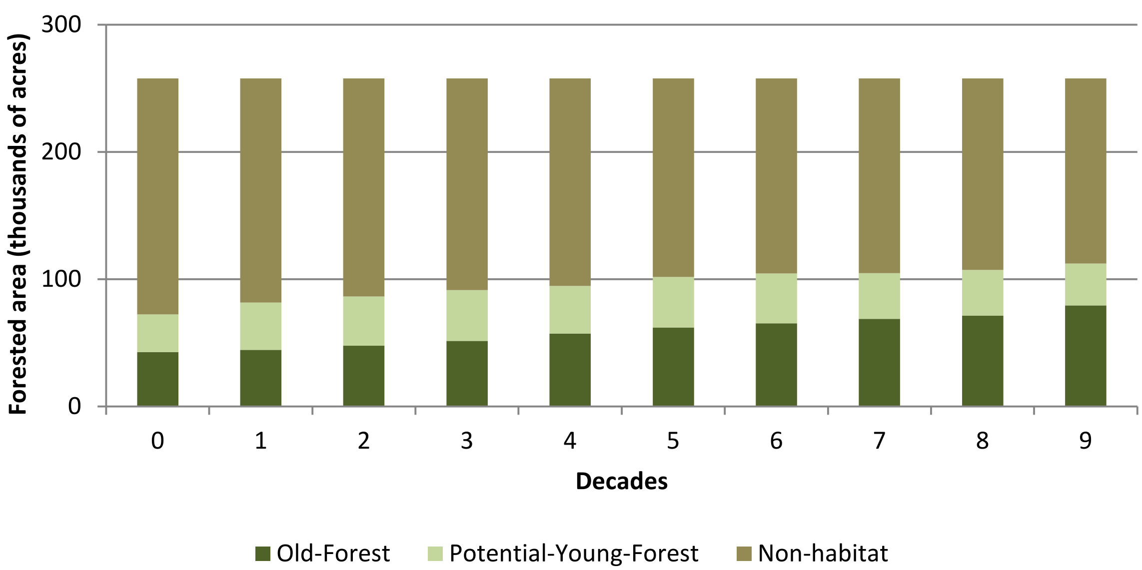


Chart A-8. Projected Acres of Old Forest Habitat by Riparian and Upland Land Classifications[4] on State Trust Lands in the OESF

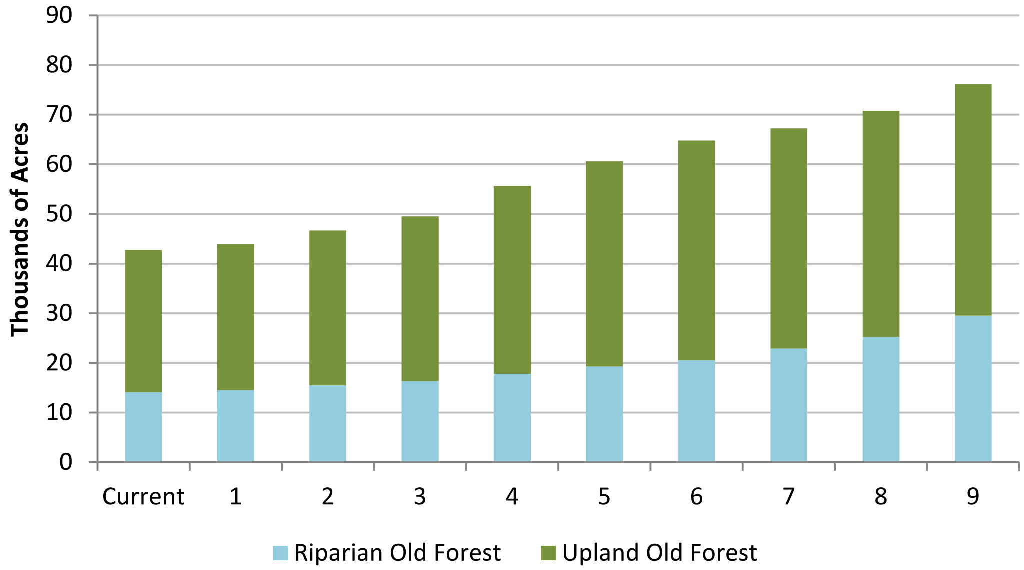


Chart A-9. Projected Acres of Young Forest Habitat by Riparian and Upland Land Classifications on State Trust Lands in the OESF

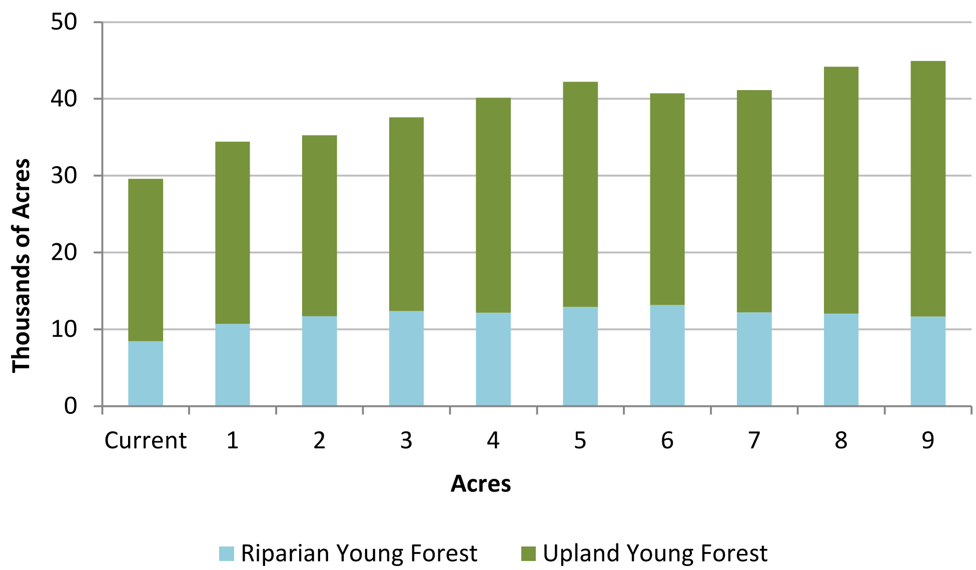
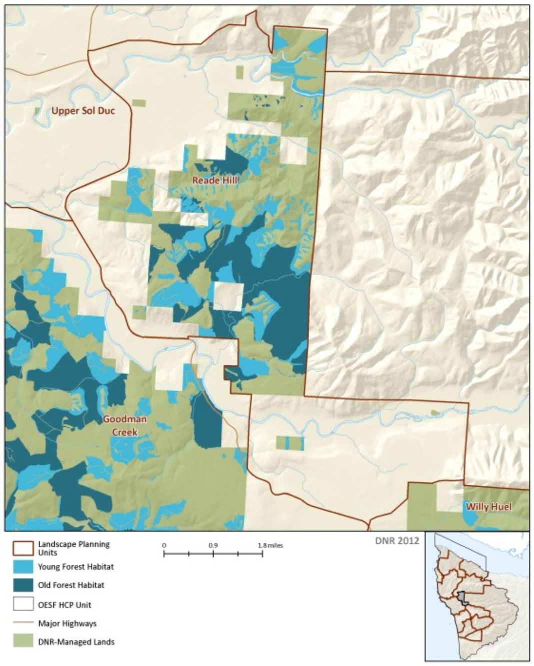


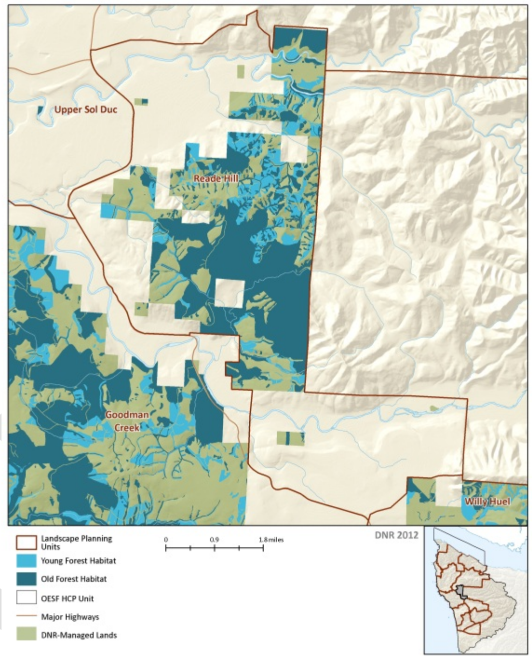
Figure A-5. Example of the Change in Old Forest Habitat on State Trust Lands in the Reade Hill Landscapes

Note increase of habitat in riparian areas.

Reade Hill Landscape, Decade 1



Reade Hill Landscape, Decade 9



OESF Landscapes

This section provides information about each of the 11 landscapes in the OESF, including a general description of each landscape and the number of acres by long-term deferrals, operable areas, and land classification. It also provides information about harvest volumes and methods, riparian conservation, and northern spotted owl habitat over the 100-year analysis period.

Because the OESF is an independent sustainable harvest unit per current DNR policy, DNR does not have goals for harvest volumes specific to each landscape. The information presented for each landscape is the expected contribution of each landscape to the overall harvest volume for the OESF, based on projections from the forest estate model.

The information provided for each landscape under the heading "Long Term Deferrals, Operable Areas, and Land Classification" is based on riparian and uplands classifications in the forest estate model.

Objectives Common to All Landscapes

Objectives that are common to all landscapes are (refer to Chapter 2):

- Harvest and sell a volume of timber that is consistent with the current sustainable harvest level for the OESF.
- Meet the measurable objectives of the riparian, northern spotted owl, marbled murrelet, and multi-species conservation strategies.

Landscapes

Clallam Landscape

The Clallam Landscape encompasses state trust lands in the Clallam River drainage as well as scattered parcels to the east in the Pysht River and Deep Creek basins. This landscape borders the Strait of Juan de Fuca. Because of its access to water-borne transportation, substantial timber harvest occurred here in the early 20th century.

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-22 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Clallam Landscape.

Table A-22. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Clallam Landscape

Land classification	Acres and percent of total		TOTAL
	Long-term deferrals	Operable	
Riparian	2,961 (17%)	870 (5%)	3,831 (22%)
Uplands	723 (4%)	12,722 (74%)	13,445 (78%)
TOTAL	**3,684 (21%)**	**13,592 (79%)**	**17,276 (100%)**

HARVEST METHODS AND VOLUMES, DECADE 1

Table A-23 shows the projected number of acres and volume of timber harvested from state trust lands in the Clallam Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-23. Harvest Methods and Volumes on State Trust Lands in the Clallam Landscape, Decade 1

	Silvicultural treatment	Edge density		
		Low to moderate	Moderate to high	TOTAL
Harvest area (acres)	Variable retention harvest	1,851	377	2,228
	Variable density thinning	91	1	92
Harvest volume (MBF)	Variable retention harvest	73,014	15,740	88,754
	Variable density thinning	3,074	24	3,098
Total harvest area (acres)		1,942	377	2,319
Total harvest volume (MBF)		76,088	15,763	91,852

AGE-CLASS DISTRIBUTION

Chart A-10 shows the current age class distribution of forested acres on state trust lands in the Clallam Landscape. Charts A-11 and A-12 show the projected 30- and 60-year age class distributions, respectively.

Chart A-10. Current Age-Class Distribution on State Trust Lands in the Clallam Landscape

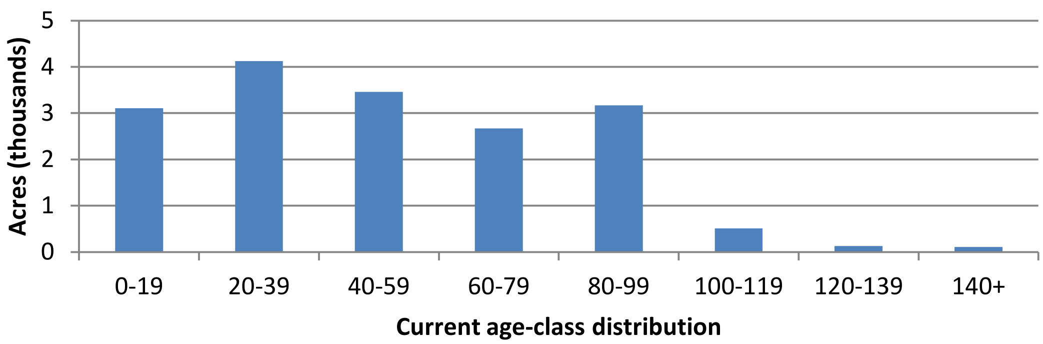


Chart A-11. Age-Class Distribution on State Trust Lands in the Clallam Landscape: 30-Year Projection

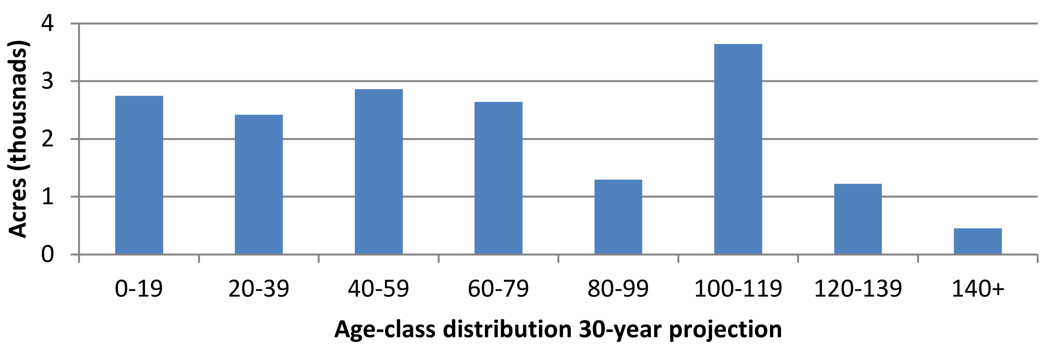
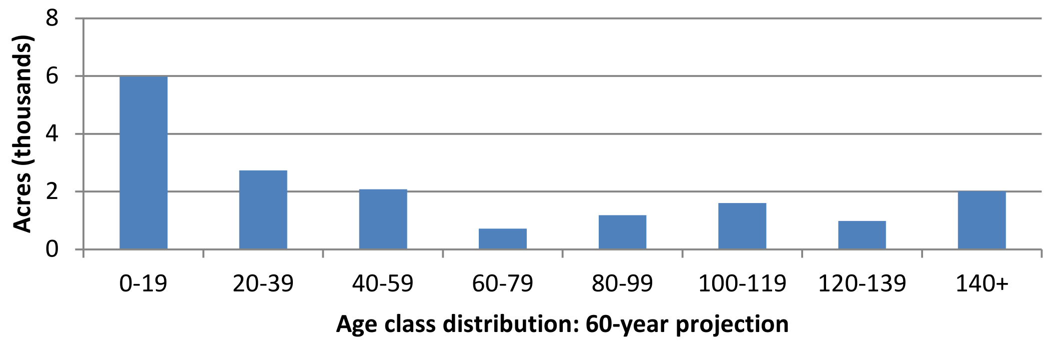


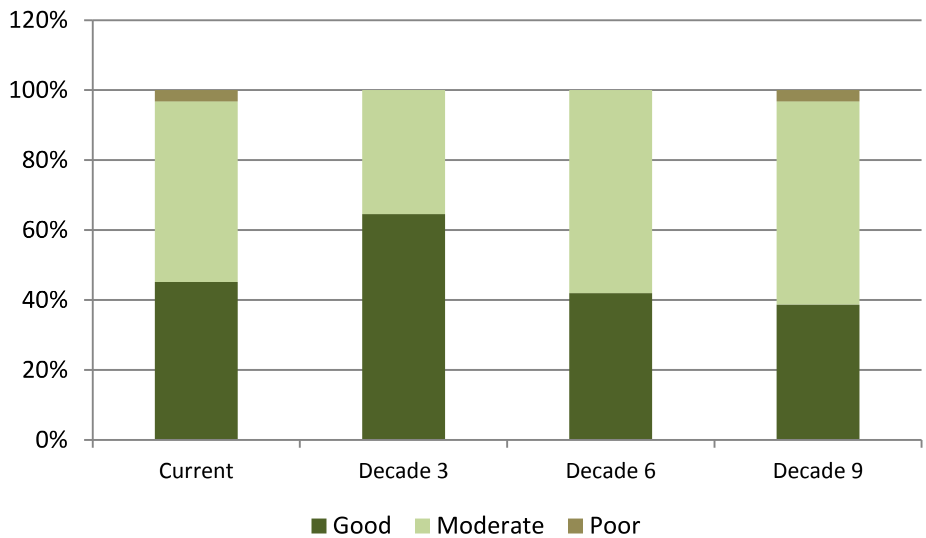
Chart A-12. Age-Class Distribution on State Trust Lands in the Clallam Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-13 shows the percent of Type 3 watersheds in the Clallam Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-13. Percent of Type 3 Watersheds in the Clallam Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The objectives for the 17,276-acre Clallam Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 6,910 acres of Young Forest Habitat or better, of which
- At least 3,455 acres are Old Forest Habitat.

Chart A-14 shows the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the Clallam Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-15 and A-16 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-14. Acres of Old and Young Forest Habitat on State Trust Lands in the Clallam Landscape Over the 100-Year Analysis Period

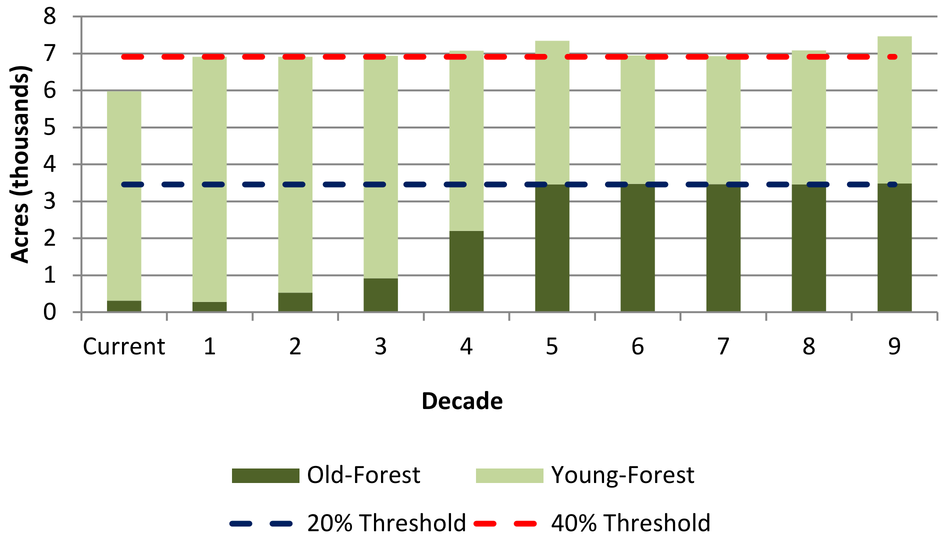


Chart A-15. Northern Spotted Owl Habitat Distribution in the Upland Land Classificationification in the Clallam Landscape Over the 100-Year Analysis Period

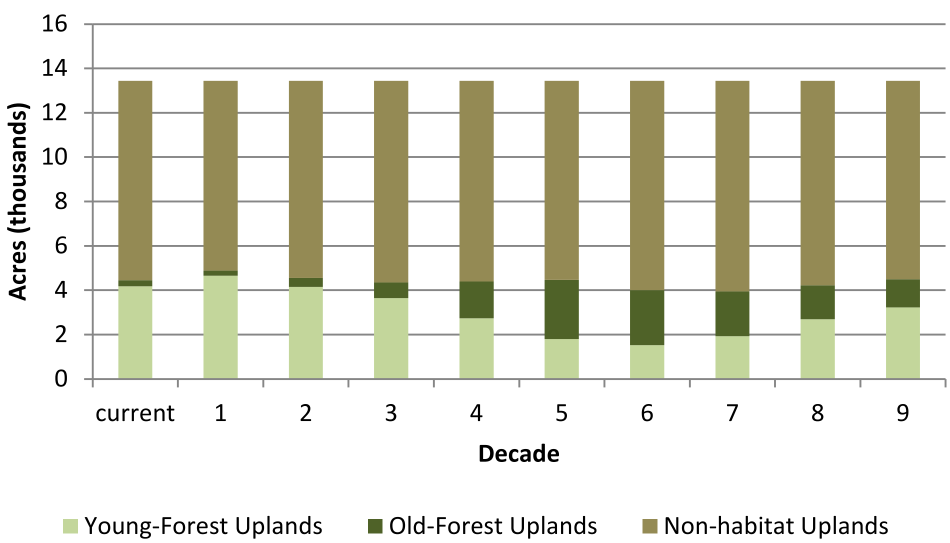
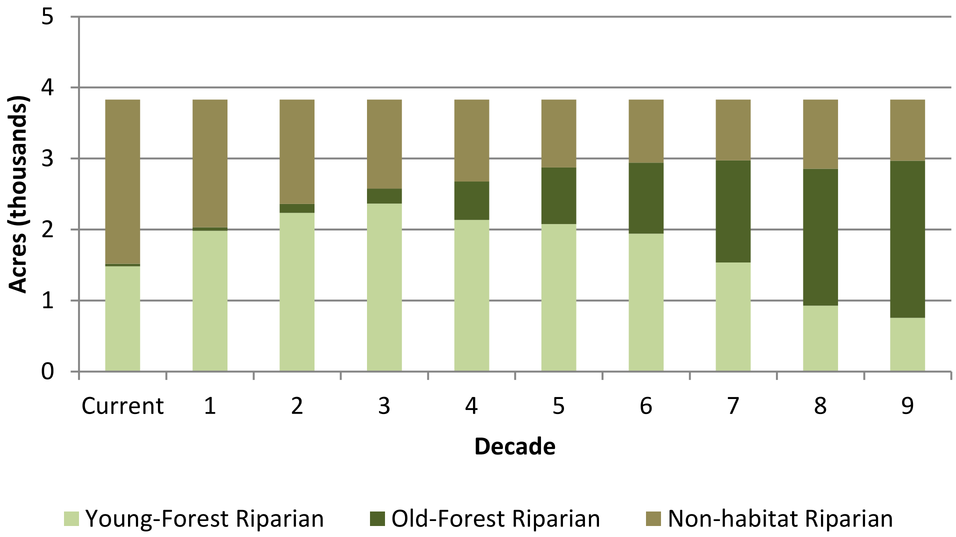


Chart A-16. Northern Spotted Owl Habitat Distribution in the Riparian Land Classificationification in the Clallam Landscape Over the 100-Year Analysis Period



Clearwater Landscape

The Clearwater River, a major tributary of the Queets River, has its headwaters on state trust lands in the Clearwater Landscape. This landscape is separated from the Queets and Hoh River basins by steep ridges. Ridge-top elevations are mostly between 2,500 and 3,500 feet with mountainous, rugged terrain occupying much of the area above 1,000 feet. DNR timber harvests from the 1960s through the 1980s resulted in a landscape dominated by plantations of young stands in the Competitive Exclusion stand development stage. However, unharvested areas provide a significant acreage of western hemlock/Pacific silver fir stands in the Structurally Complex stage, mostly in the mid and upper elevations.

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-24 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Clearwater Landscape.

Table A-24. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Clearwater Landscape

	Acres and percent of total		
Land classification	**Long-term deferrals**	**Operable**	**TOTAL**
Riparian	18,666 (34%)	1,324 (2%)	19,990 (36%)
Uplands	13,513 (24%)	21,700 (39%)	35,213 (64%)
TOTAL	**32,179 (58%)**	**23,024 (42%)**	**55,203 (100%)**

HARVEST METHODS AND VOLUMES, DECADE 1

Table A-25 shows the projected number of acres and volume of timber harvested from state trust lands in the Clearwater Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-25. Harvest Methods and Volumes on State Trust Lands in the Clearwater Landscape, Decade 1

		Edge density		
	Silvicultural treatment	**Low to moderate**	**Moderate to high**	**TOTAL**
Harvest area (acres)	**Variable retention harvest**	1,474	409	1,883
	Variable density thinning	0		0
Harvest volume (MBF)	**Variable retention harvest**	31,047	8,439	39,486
	Variable density thinning	0		0
Total harvest area (acres)		1,474	409	1,883
Total harvest volume (MBF)		31,047	8,439	39,487

AGE-CLASS DISTRIBUTION

Chart A-17 shows the current age class distribution of forested acres on state trust lands in the Clearwater Landscape. Charts A-18 and A-19 show the projected 30- and 60-year age class distributions, respectively.

Chart A-17. Current Age Class Distribution on State Trust Lands in the Clearwater Landscape

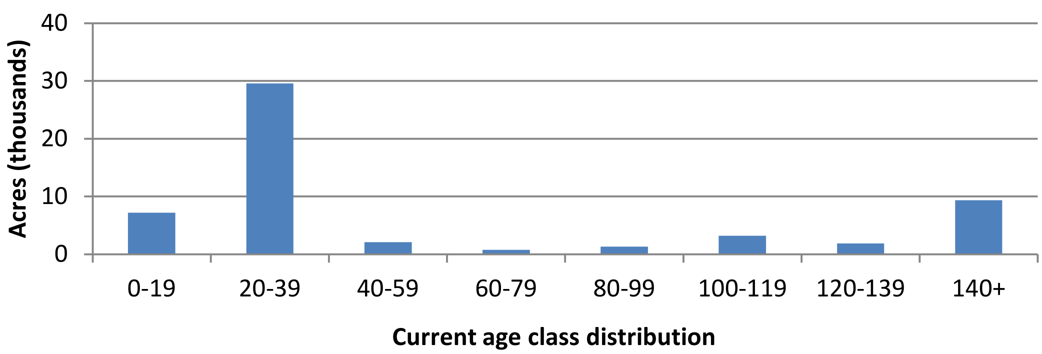


Chart A-18. Age-Class Distribution on State Trust Lands in the Clearwater Landscape: 30-Year Projection

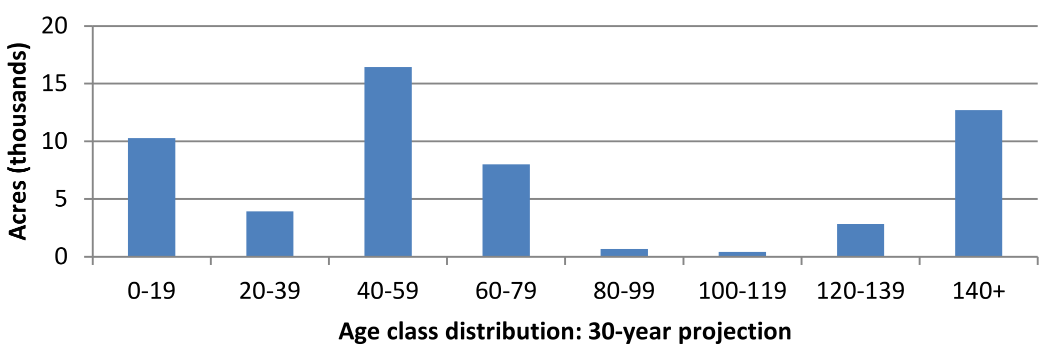
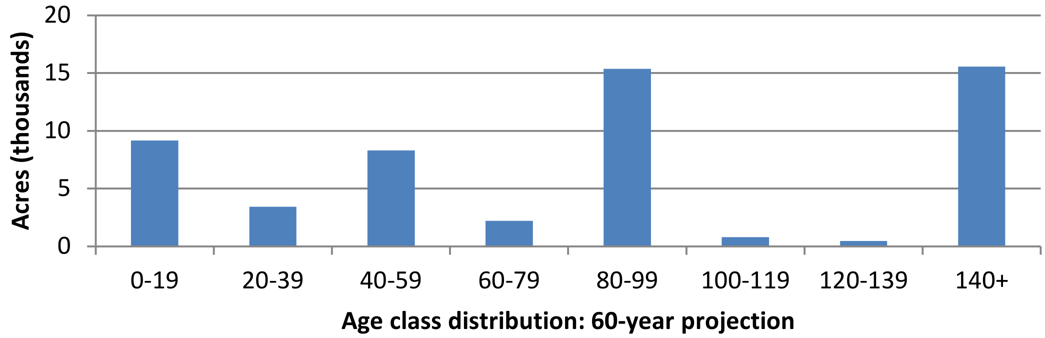


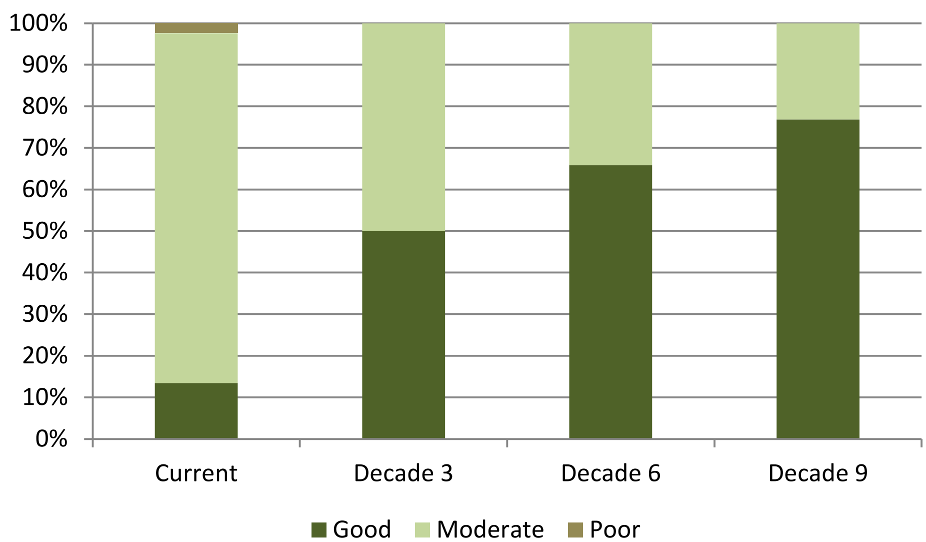
Chart A-19. Age-Class Distribution on State Trust Lands in the Clearwater Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-20 shows the percent of Type 3 watersheds in the Clearwater Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-20. Percent of Type 3 Watersheds in the Clearwater Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The objectives for the 55,203-acre Clearwater Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 22,081 acres (40 percent) of Young Forest Habitat or better, of which
- At least 11,041 acres (20 percent) are Old Forest Habitat.

Chart A-21 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Clearwater Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-22 and A-23 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-21. Acres of Old and Young ForestHabitat on State Trust Lands in the Clearwater Landscape Over the 100-Year Analysis Period

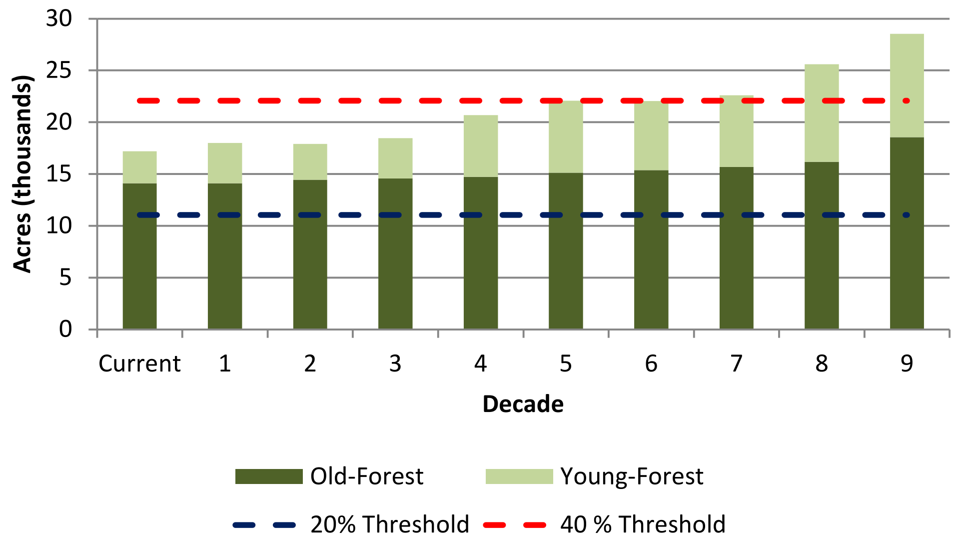


Chart A-22. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Clearwater Landscape Over the 100-Year Analysis Period

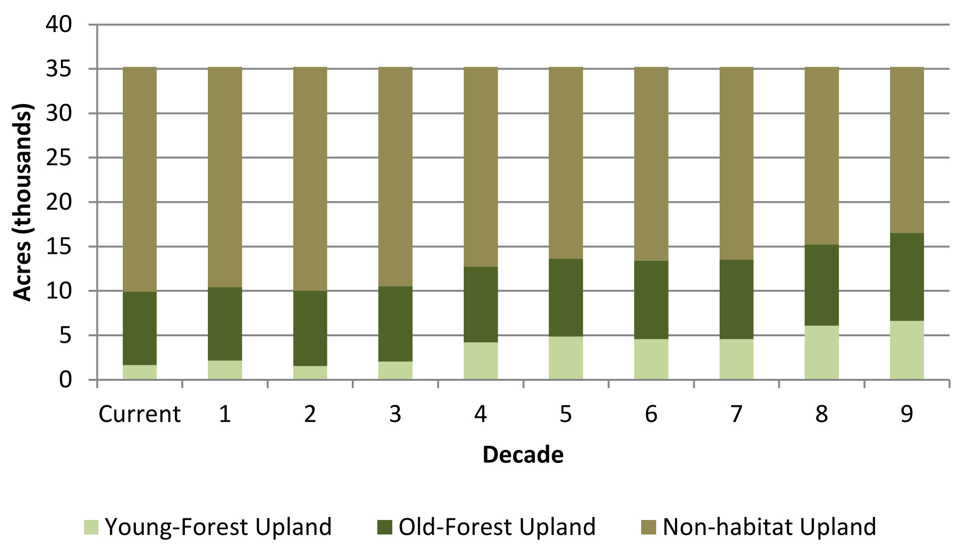
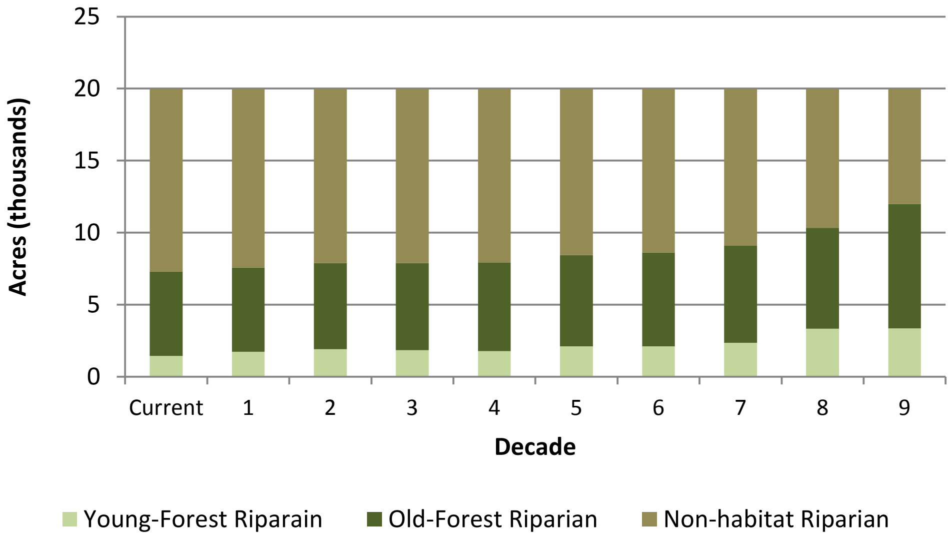


Chart A-23. Northern Spotted Owl Habitat Distribution in the Riparian Land Classification in the Clearwater Landscape Over the 100-Year Analysis Period



Coppermine Landscape

The Coppermine Landscape in the OESF is named for the DNR campground "Coppermine Bottom" on the lower Clearwater River. DNR manages approximately half of this lower-elevation landscape, which is largely foothill terrain with moderate slopes. Timber harvests beginning in the 1960s resulted in a landscape dominated by plantations of young western hemlock/Douglas-fir stands in the Competitive Exclusion stand development stage.

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-26 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Coppermine Landscape.

Table A-26. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Coppermine Landscape

Land classification	Acres and percent of total		TOTAL
	Long-term deferrals	Operable	
Riparian	5,479 (28%)	905 (5%)	6,384 (33%)
Uplands	3,521 (18%)	9,341 (48%)	12,862 (67%)
TOTAL	**9,000 (47%)**	**10,246 (53%)**	**19,246 (100%)**

HARVEST METHODS AND VOLUMES, DECADE 1

Table A-27 shows the projected number of acres and volume of timber harvested from state trust lands in the Coppermine Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-27. Harvest Methods and Volumes on State Trust Lands in the Coppermine Landscape, Decade 1

	Silvicultural treatment	Edge density: Low to moderate	Edge density: Moderate to high	TOTAL
Harvest area (acres)	**Variable retention harvest**	843	439	1,283
	Variable density thinning	0	0	0
Harvest volume (MBF)	**Variable retention harvest**	18,814	9,861	28,676
	Variable density thinning	0	0	0
Total harvest area (acres)		843	439	1,283
Total harvest volume (MBF)		18,814	9,861	28,676

AGE-CLASS DISTRIBUTION

Chart A-24 shows the current age class distribution of forested acres on state trust lands in the Coppermine Landscape. Charts A-25 and A-26 show the projected 30- and 60-year age class distributions, respectively.

Chart A-24. Current Age Class Distribution on State Trust Lands in the Coppermine Landscape

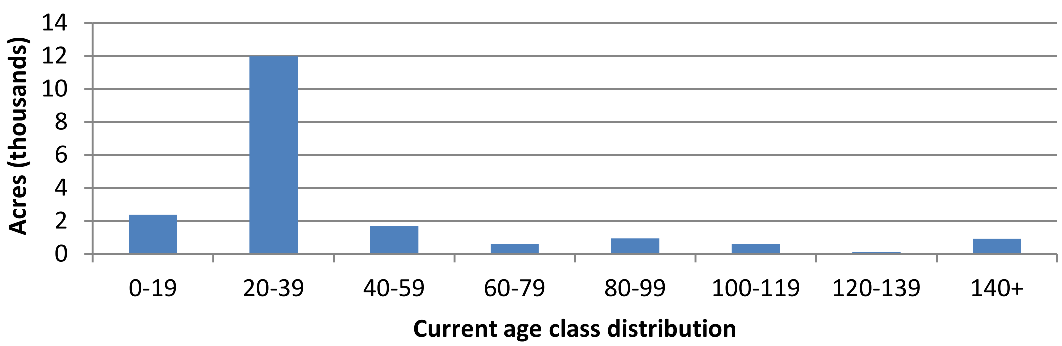


Chart A-25. Age-Class Distribution on State Trust Lands in the Coppermine Landscape: 30-Year Projection

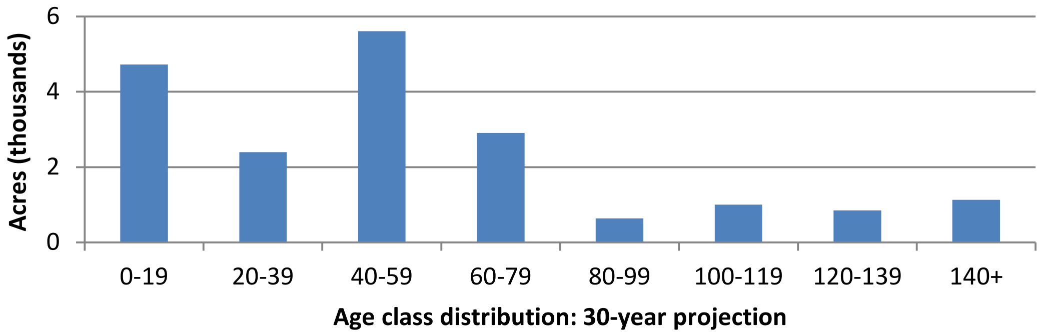
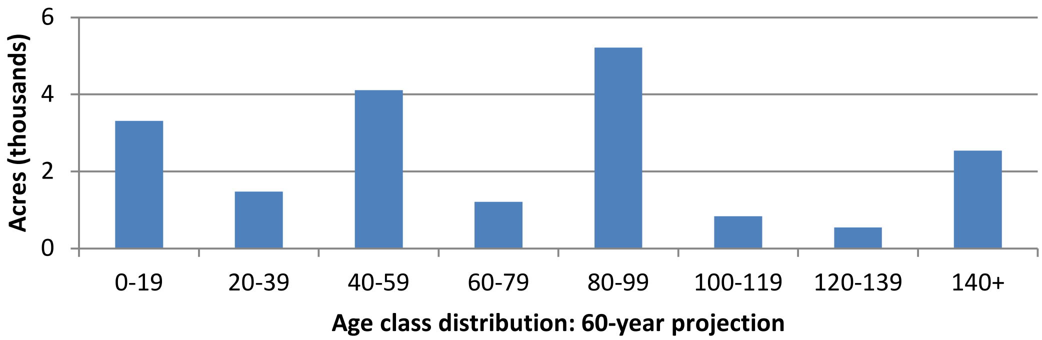


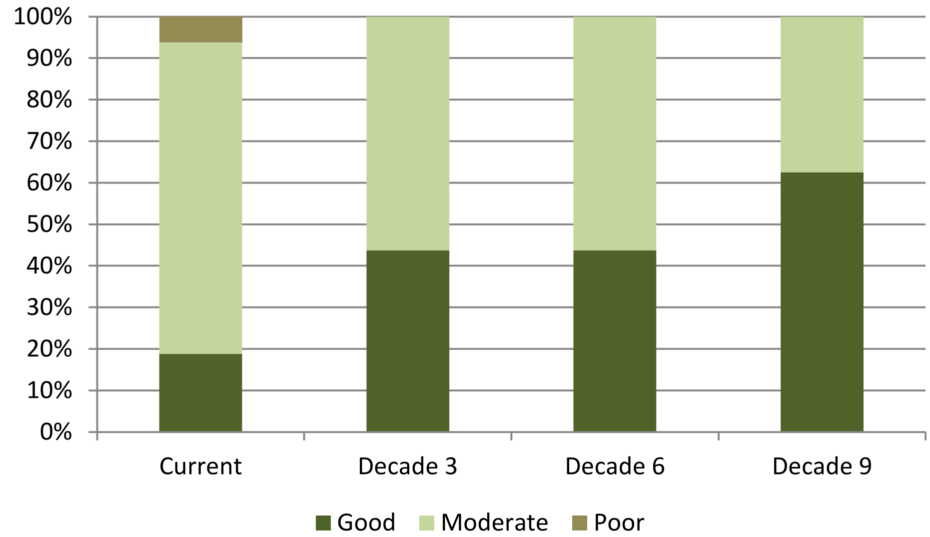
Chart A-26. Age-Class Distribution on State Trust Lands in the Coppermine Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-27 shows the percent of Type 3 watersheds in the Coppermine Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-27. Percent of Type 3 Watersheds in the Coppermine Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The major objectives for the 19,246-acre Coppermine Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 7,698 acres (40%) of Young Forest Habitat or better, of which
- At least 3,849 acres (20%) are Old Forest Habitat.

Chart A-28 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Coppermine Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-29 and A-30 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-28. Acres of Old and Young Forest on State Trust Lands in the Coppermine Landscape Over the 100-Year Analysis Period

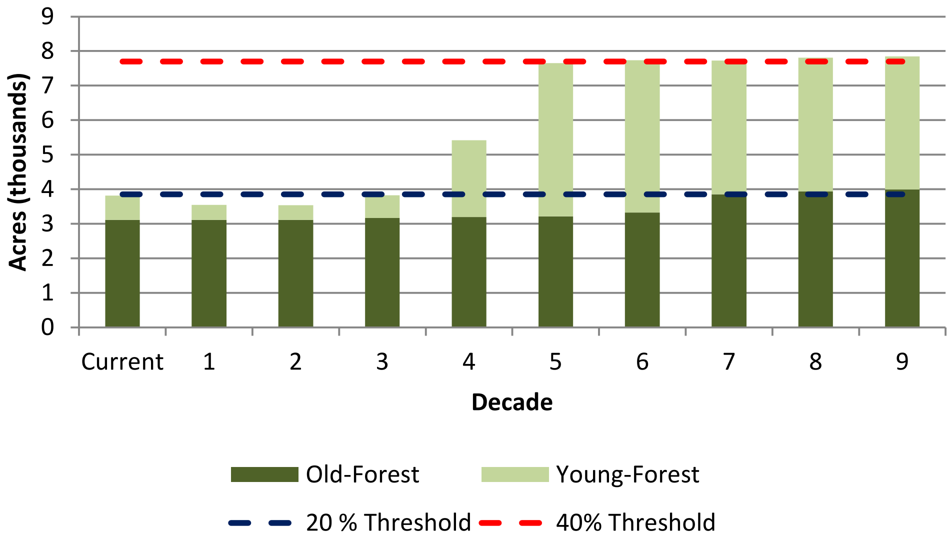


Chart A-29. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Coppermine Landscape Over the 100-Year Analysis Period

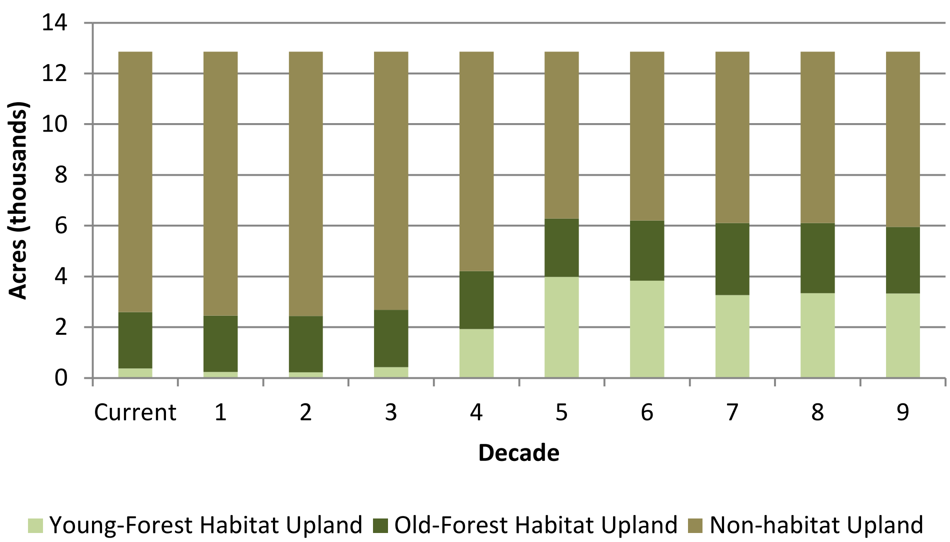
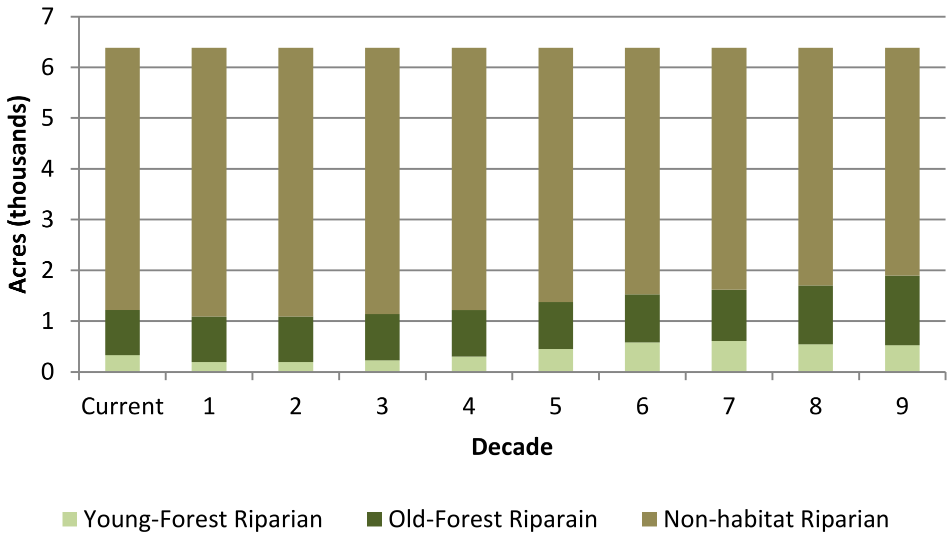


Chart A-30. Northern Spotted Owl Habitat Distribution in the Riparian Land Classification in the Coppermine Landscape Over the 100-Year Analysis Period



Dickodochtedar Landscape

The Dickodochtedar Landscape, which bears the Quileute name for what is now called the Dickey River (Powell and others, undated), occupies much of the coastal plain on the northwest Olympic Peninsula. This landscape was largely shaped by continental glaciation and is dominated by private industrial forest lands. DNR manages about one-fourth of this landscape. These low-elevation forestlands are productive for timber.

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-28 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Dickodochtedar Landscape.

Table A-28. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Dickodochtedar Landscape

Land classification	Acres and percent of total		TOTAL
	Long-term deferrals	Operable	
Riparian	3,079 (11%)	1,797 (6%)	4,876 (17%)
Uplands	5,215 (19%)	17,956 (64%)	23,171 (83%)
TOTAL	**8,294 (30%)**	**19,753 (70%)**	**28,047 (100%)**

HARVEST METHODS AND VOLUMES, DECADE 1

Table A-29 shows the projected number of acres and volume of timber harvested from state trust lands in the Dickodochtedar Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-29. Harvest Methods and Volumes on State Trust Lands in the Dickodochtedar Landscape, Decade 1

		Edge density		
	Silvicultural treatment	**Low to moderate**	**Moderate to high**	**TOTAL**
Harvest area (acres)	**Variable retention harvest**	1,809	171	1,980
	Variable density thinning	0	0	0
Harvest volume (MBF)	**Variable retention harvest**	55,739	5,395	61,134
	Variable density thinning	0	0	0
Total harvest area (acres)		1,809	171	1,980
Total harvest volume (MBF)		55,739	5,395	61,134

AGE-CLASS DISTRIBUTION

Chart A-31 shows the current age class distribution of forested acres on state trust lands in the Dickodochtedar Landscape. Charts A-32 and A-33 show the projected 30- and 60-year age class distributions, respectively.

Chart A-31. Current Age Class Distribution on State Trust Lands in the Dickodochtedar Landscape

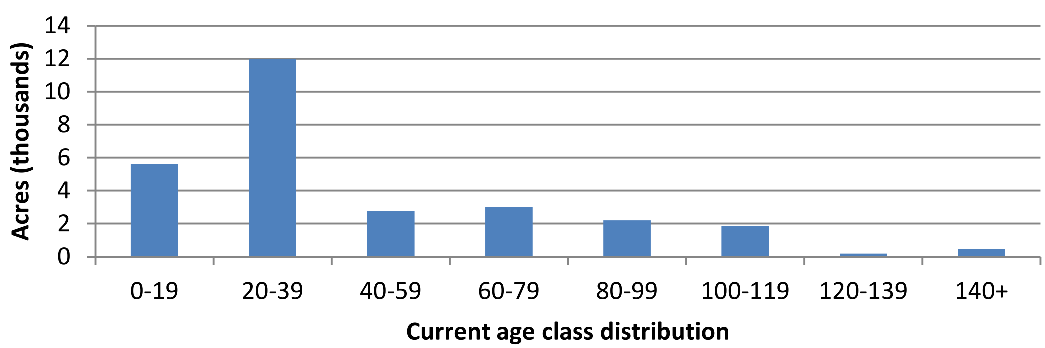


Chart A-32. Age-Class Distribution on State Trust Lands in the Dickodochtedar Landscape: 30-Year Projection

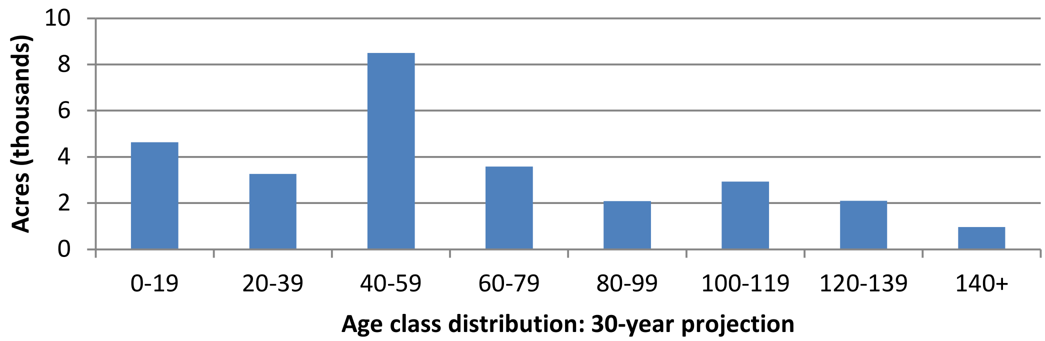
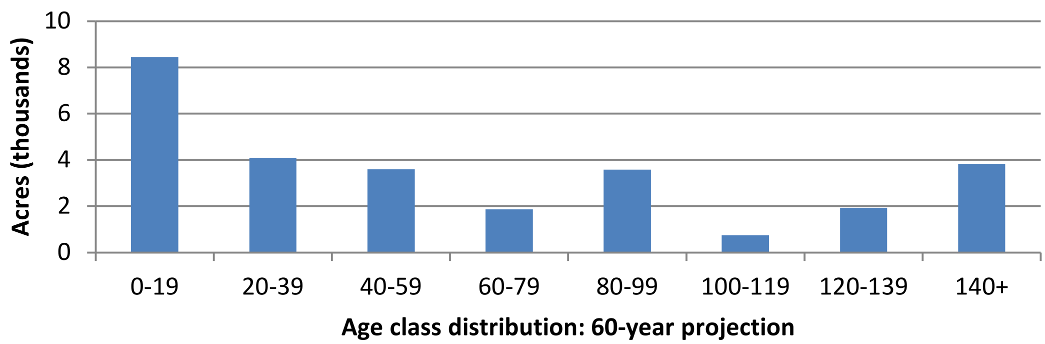


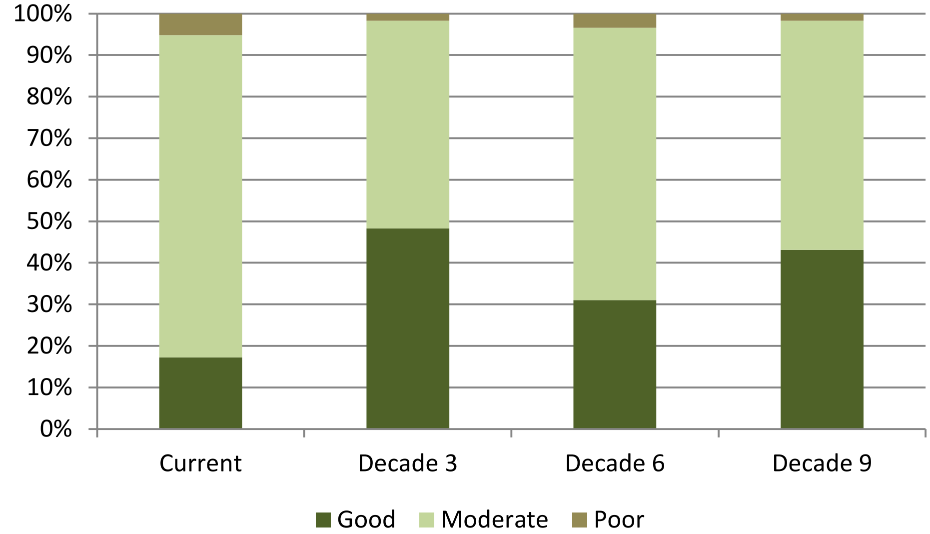
Chart A-33. Age-Class Distribution on State Trust Lands in the Dickodochtedar Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-34 shows the percent of Type 3 watersheds in the Dickodochtedar Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-34. Percent of Type 3 Watersheds in the Dickodochtedar Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The objectives for the 28,047-acre Dickodochtedar Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 11,219 acres (40 percent) of Young Forest Habitat or better, of which
- At least 5,609 acres (20 percent) are Old Forest Habitat.

Chart A-35 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Dickodochtedar Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-36 and A-37 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-35. Acres of Old and Young Forest on State Trust Lands in the Dickodochtedar Landscape Over the 100-Year Analysis Period

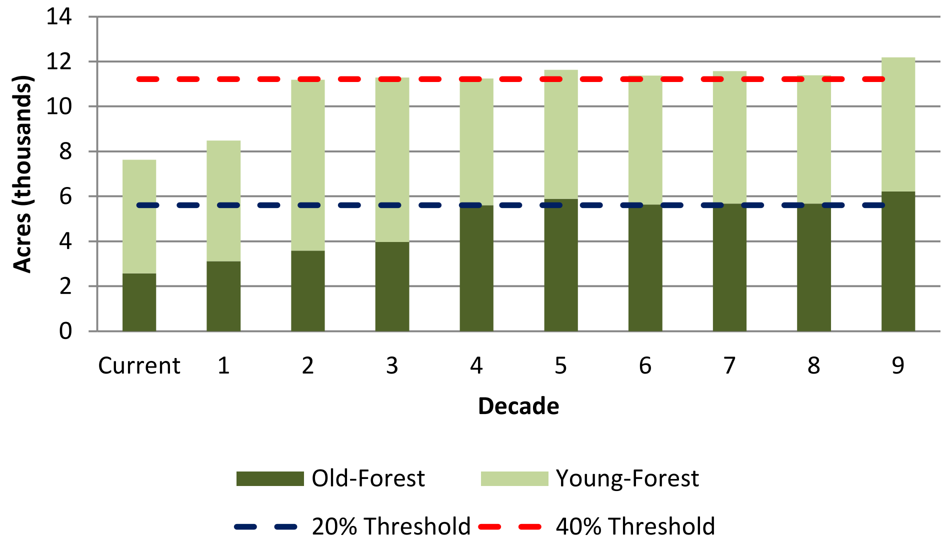


Chart A-36. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Dickodochtedar Landscape Over the 100-Year Analysis Period

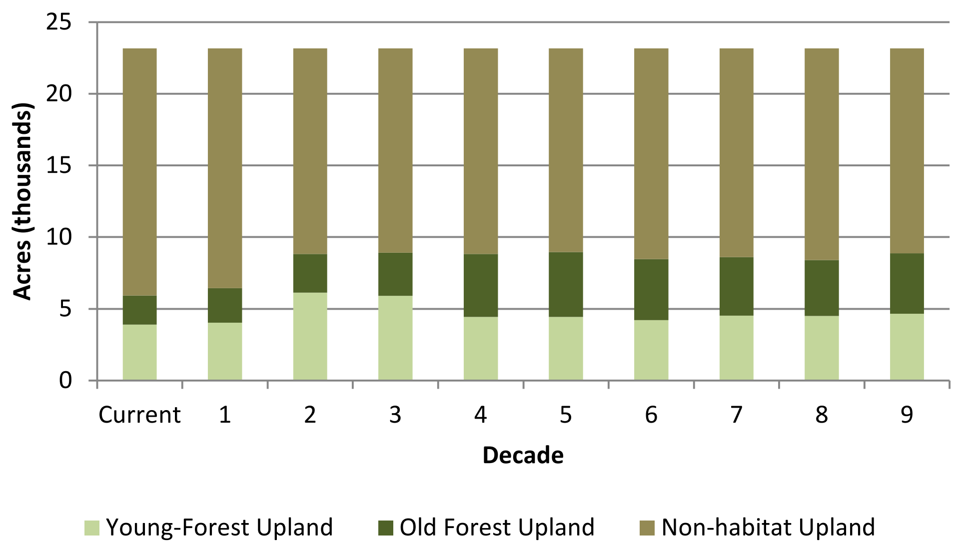
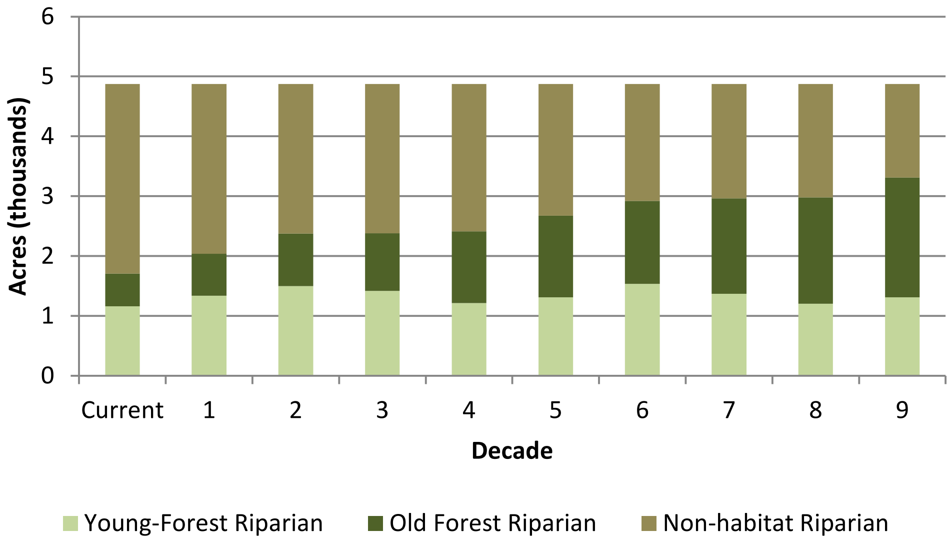


Chart A-37. Northern Spotted Owl Habitat Distribution in the Riparian Land Classification in the Dickodochtedar Landscape Over the 100-Year Analysis Period



Goodman Landscape

This low-elevation coastal landscape encompasses two small, discrete coastal basins, Goodman and Mosquito creeks, as well as state trust lands draining to the lower Bogachiel River. Old-growth western redcedar stands are a notable feature of some state trust lands in the Goodman Creek basin.

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-30 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Goodman Landscape.

Table A-30. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Goodman Landscape

Land Classification	Acres and percent of total		TOTAL
	Long-term deferrals	Operable	
Riparian	3,521 (15%)	1,165 (5%)	4,686 (20%)
Uplands	6,241 (26%)	12,871 (54%)	19,113 (80%)
TOTAL	**9,763 (41%)**	**14,036 (59%)**	**23,799 (100%)**

HARVEST METHODS AND VOLUMES, DECADE 1

Table A-31 shows the projected number of acres and volume of timber harvested from state trust lands in the Goodman Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-31. Harvest Methods and Volumes on State Trust Lands in the Goodman Landscape, Decade 1

	Silvicultural treatment	Edge density: Low to moderate	Edge density: Moderate to high	TOTAL
Harvest area (acres)	**Variable retention harvest**	1,206	127	1,333
	Variable density thinning	0	0	0
Harvest volume (MBF)	**Variable retention harvest**	32,098	3,998	36,096
	Variable density thinning	0	0	0
Total harvest area (acres)		1,206	127	1,333
Total harvest volume (MBF)		32,098	3,998	36,096

AGE-CLASS DISTRIBUTION

Chart A-38 shows the current age class distribution of forested acres on state trust lands in the Goodman Landscape. Charts A-39 and A-40 show the projected 30- and 60-year age class distributions, respectively.

Chart A-38. Current Age Class Distribution on State Trust Lands in the Goodman Landscape

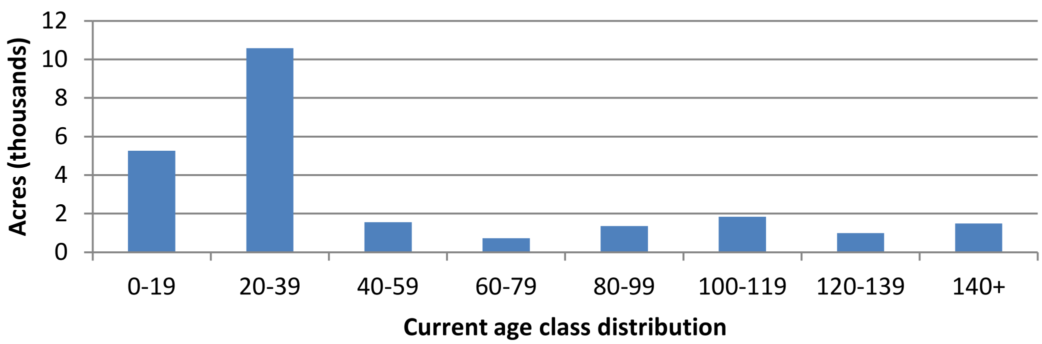


Chart A-39. Age-Class Distribution on State Trust Lands in the Goodman Landscape: 30-Year Projection

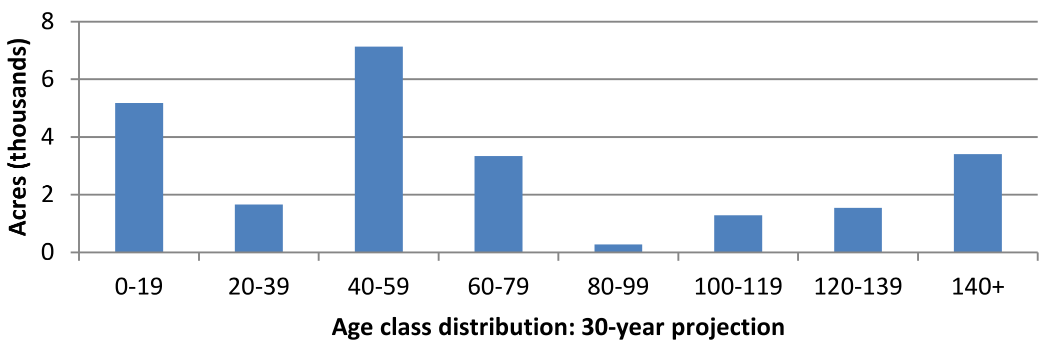
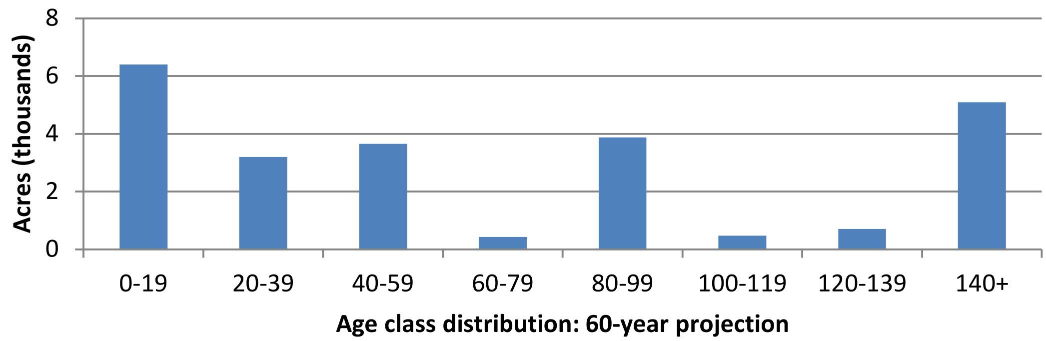


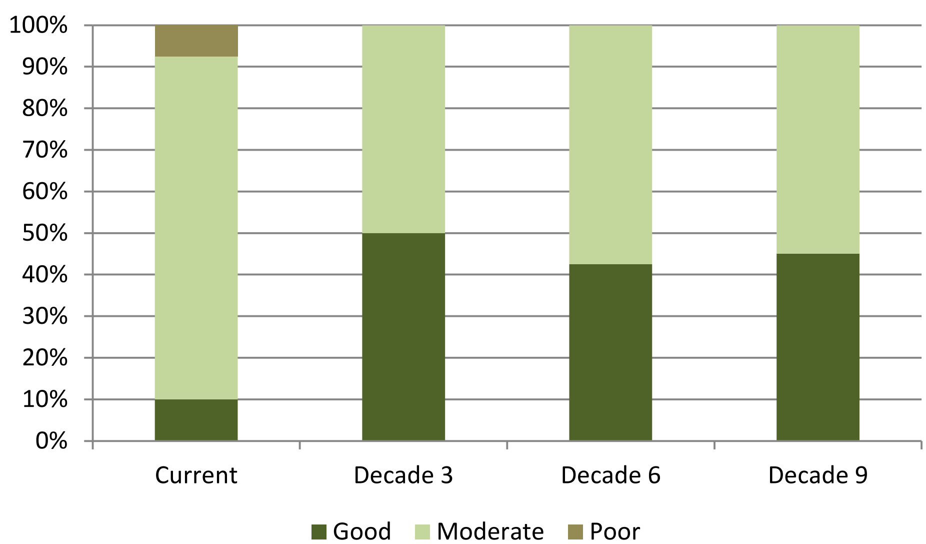
Chart A-40. Age-Class Distribution on State Trust Lands in the Goodman Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-41 shows the percent of Type 3 watersheds in the Goodman Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-41. Percent of Type 3 Watersheds in the Goodman Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The objectives for the 23,799-acre Goodman Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 9,520 acres (40 percent)of Young Forest Habitat or better, of which
- At least 4,760 acres (20 percent) are Old Forest Habitat.

Chart A-42 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Goodman Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-43 and A-44 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-42. Acres of Old and Young Forest on State Trust Lands in the Goodman Landscape Over the 100-Year Analysis Period

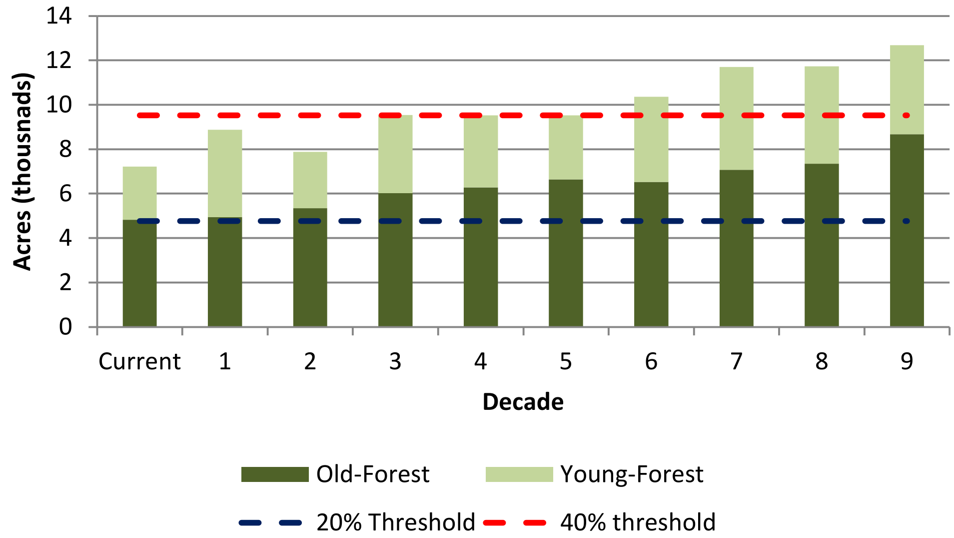


Chart A-43. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Goodman Landscape Over the 100-Year Analysis Period

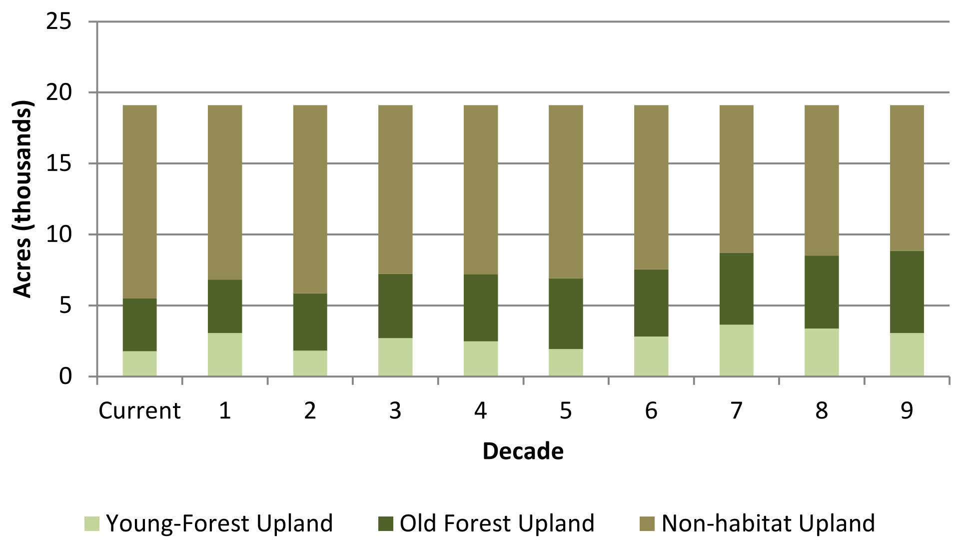
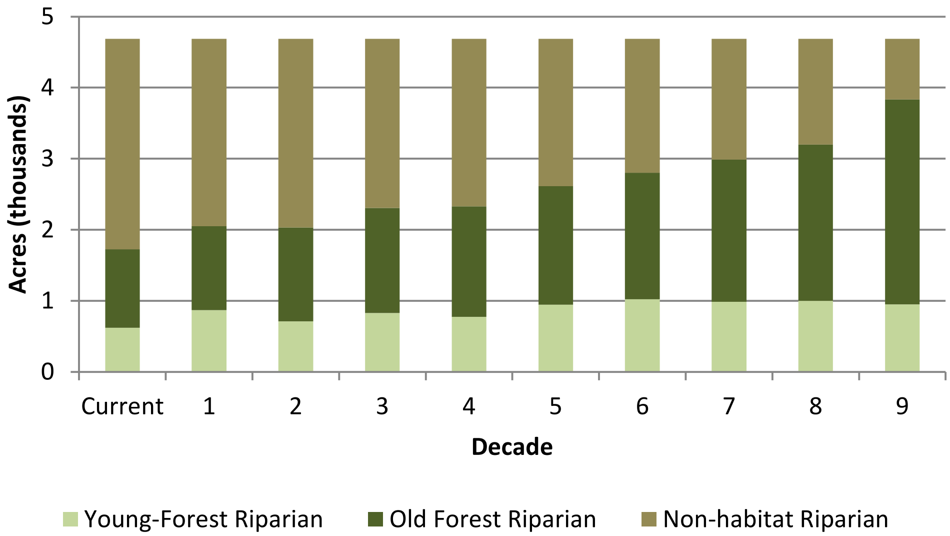


Chart A-44. Northern Spotted Owl Habitat Distribution in the Riparian Land Classification in the Goodman Landscape Over the 100-Year Analysis Period



Kalaloch Landscape

This low-elevation coastal landscape encompasses Cedar and Kalaloch creeks; small, discrete coastal basins; and the lower Hoh River. State trust lands are most abundant in the Kalaloch, Cedar, and Nolan (Hoh tributary) creek basins, where previous intensive forest management resulted in many Douglas-fir/western hemlock plantations. Notable stands of old-growth western red cedar are conserved in several areas of this landscape, including the South Nolan Natural Resource Conservation Area.[5]

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-32 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Kalaloch Landscape.

Table A-32. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Kalaloch Landscape

Land classification	Acres and percent of total		TOTAL
	Long-term deferrals	Operable	
Riparian	4,192 (23%)	1,039 (6%)	5,231 (29%)
Uplands	3,781 (21%)	9,110 (50%)	12,891 (71%)
TOTAL	**7,973 (44%)**	**10,149 (56%)**	**18,122 (100%)**

SILVICULTURAL SYSTEMS AND VOLUMES, DECADE 1

Table A-33 shows the projected number of acres and volume of timber harvested from state trust lands in the Kalaloch Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-33. Harvest Methods and Volumes on State Trust Lands in the Kalaloch Landscape, Decade 1

		Edge density		
	Silvicultural treatment	**Low to moderate**	**Moderate to high**	**TOTAL**
Harvest area (acres)	**Variable retention harvest**	912	559	1,471
	Variable density thinning	4	0	4
Harvest volume (MBF)	**Variable retention harvest**	20,618	13,178	33,796
	Variable density thinning	83	0	83
Total harvest area (acres)		916	559	1,475
Total harvest volume (MBF)		20,701	13,178	33,879

AGE-CLASS DISTRIBUTION

Chart A-45 shows the current age class distribution of forested acres on state trust lands in the Kalaloch Landscape. Charts A-46 and A-47 show the projected 30- and 60-year age class distributions, respectively.

Chart A-45. Current Age-Class Distribution on State Trust Lands in the Kalaloch Landscape

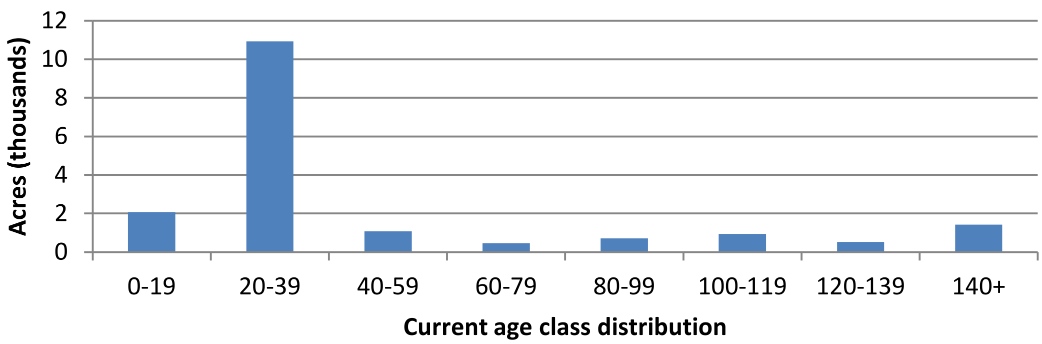


Chart A-46. Age-Class Distribution on State Trust Lands in the Kalaloch Landscape: 30-Year Projection

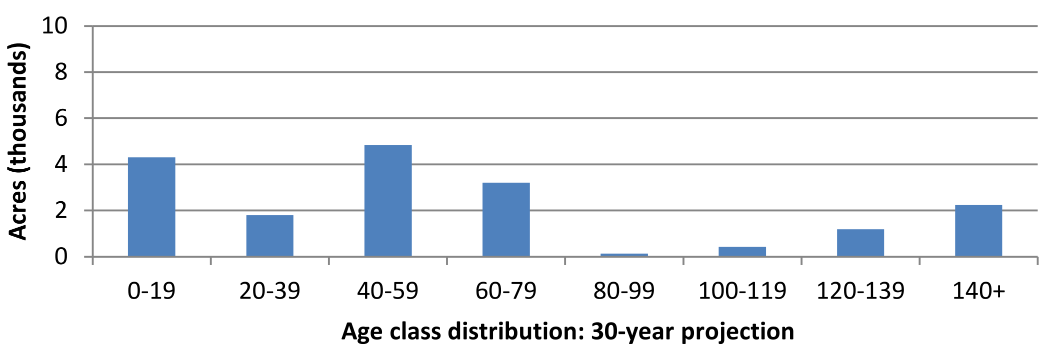
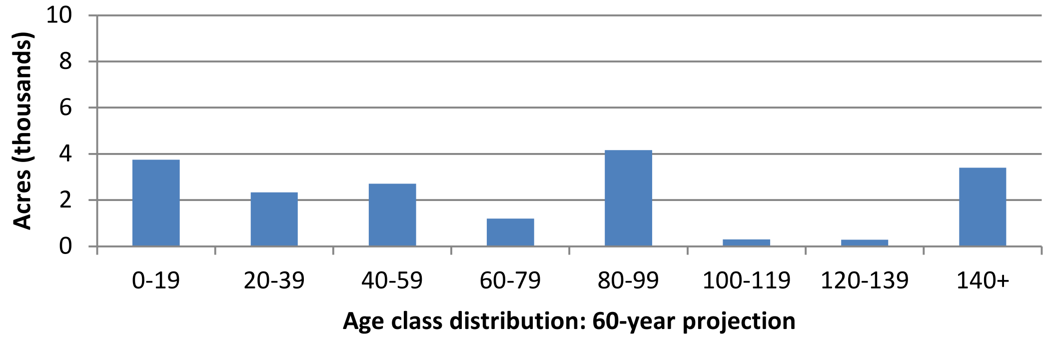


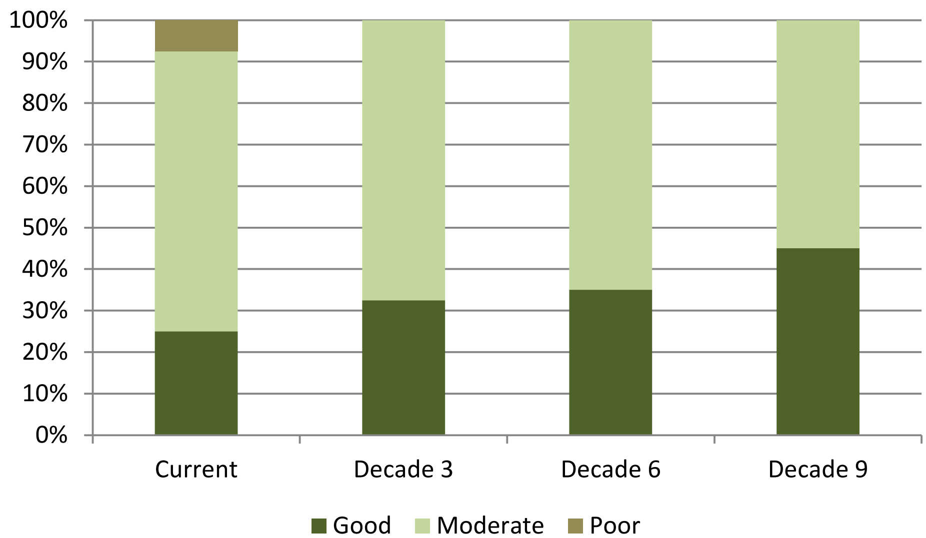
Chart A-47. Age-Class Distribution on State Trust Lands in the Kalaloch Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-48 shows the percent of Type 3 watersheds in the Kalaloch Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-48. Percent of Type 3 Watersheds in the Kalaloch Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The objectives for the 18,122-acre Kalaloch Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 7,249 acres (40 percent) of Young Forest Habitat or better, of which
- At least 3,624 acres (20 percent) are Old Forest Habitat.

Chart A-49 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Kalaloch Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-50 and A-51 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-49. Acres of Old and Young Forest on State Trust Lands in the Kalaloch Landscape Over the 100-Year Analysis Period

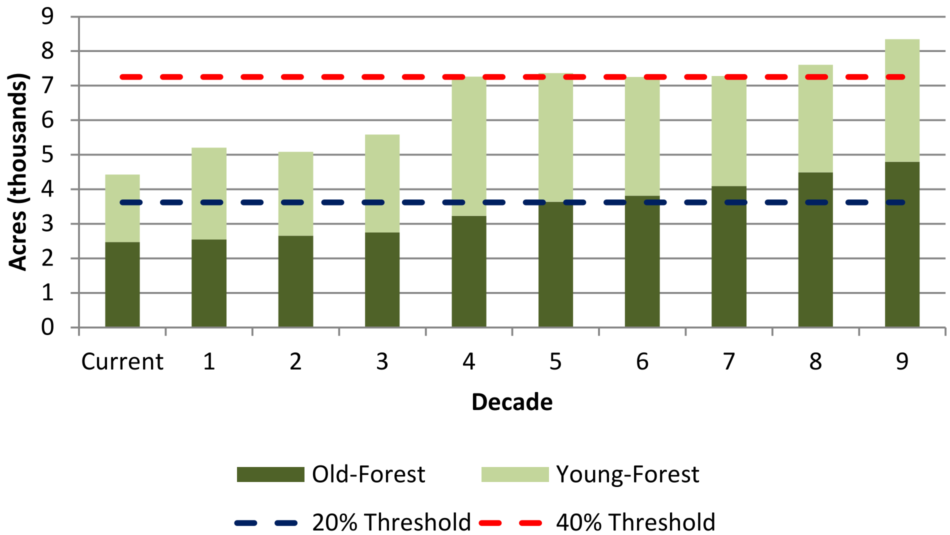


Chart A-50. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Kalaloch Landscape Over the 100-Year Analysis Period

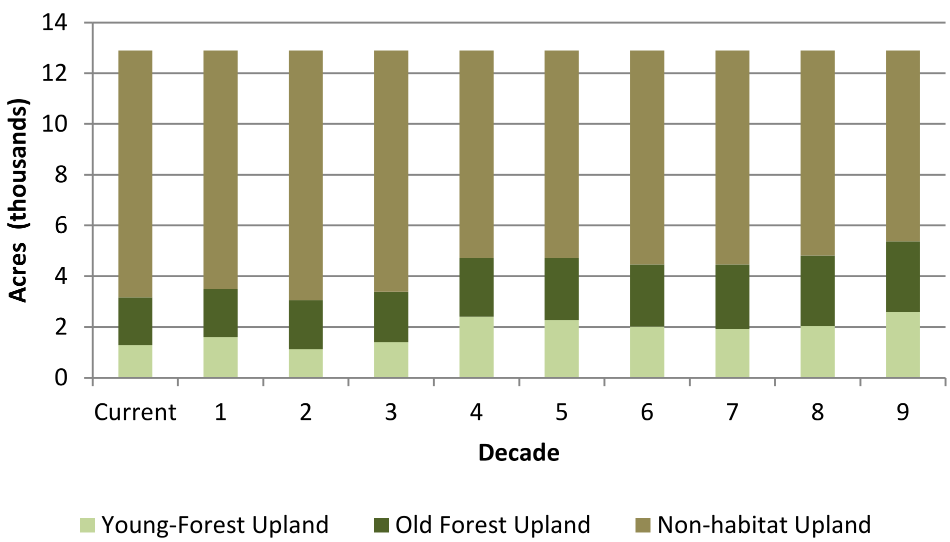
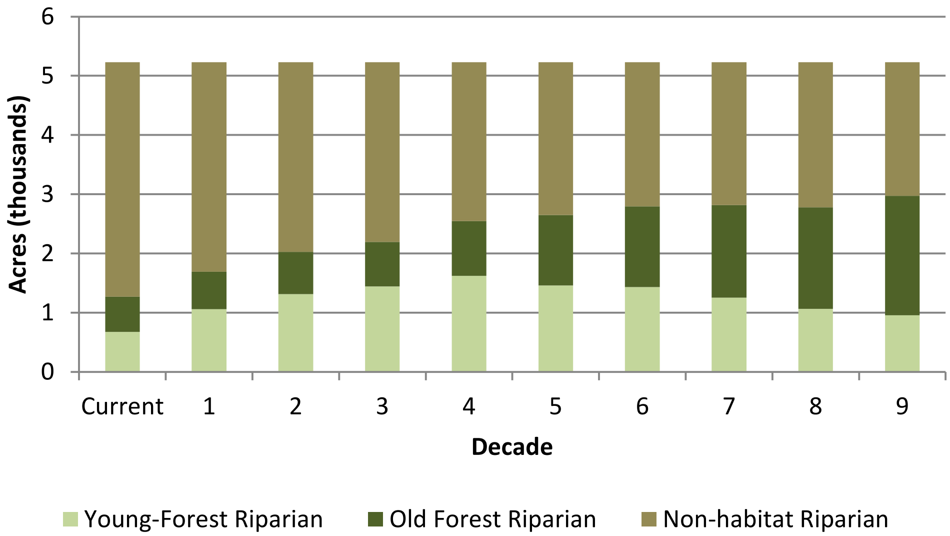


Chart A-51. Northern Spotted Owl Habitat Distribution in the Riparian Land Classification in the Kalaloch Landscape Over the 100-Year Analysis Period



Queets Landscape

The Queets Corridor of the Olympic National Park bisects this low-elevation landscape, which was largely shaped by alpine glaciers during the last ice age. State trust lands comprise most of this landscape, which is dominated by Douglas-fir/western hemlock plantations resulting from previous intensive timber management.

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-34 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Queets Landscape.

Table A-34. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Queets Landscape

Land classification	Acres and percent of total		TOTAL
	Long-term deferrals	Operable	
Riparian	2,663 (13%)	591 (3%)	3,254 (16%)
Uplands	6,582 (31%)	10,971 (53%)	17,552 (84%)
TOTAL	**9,245 (44%)**	**11,562 (56%)**	**20,807 (100%)**

HARVEST METHODS AND VOLUMES, DECADE 1

Table A-35 shows the projected number of acres and volume of timber harvested from state trust lands in the Queets Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-35. Harvest Methods and Volumes on State Trust Lands in the Queets Landscape, Decade 1

	Silvicultural treatment	Edge density		
		Low to moderate	Moderate to high	TOTAL
Harvest area (acres)	**Variable retention harvest (VRH)**	1,507	62	1,569
	Variable density thinning (VDT)	0	0	0
Harvest volume (MBF)	**Variable retention harvest (VRH)**	28,317	1,502	29,818
	Variable density thinning (VDT)	0	0	0
Total harvest area (acres)		1,507	62	1,569
Total harvest volume (MBF)		28,317	1,502	29,818

AGE-CLASS DISTRIBUTION

Chart A-52 shows the current age class distribution of forested acres on state trust lands in the Queets Landscape. Charts A-53 and A-54 show the projected 30- and 60-year age class distributions, respectively.

Chart A-52. Current Age-Class Distribution on State Trust Lands in the Queets Landscape

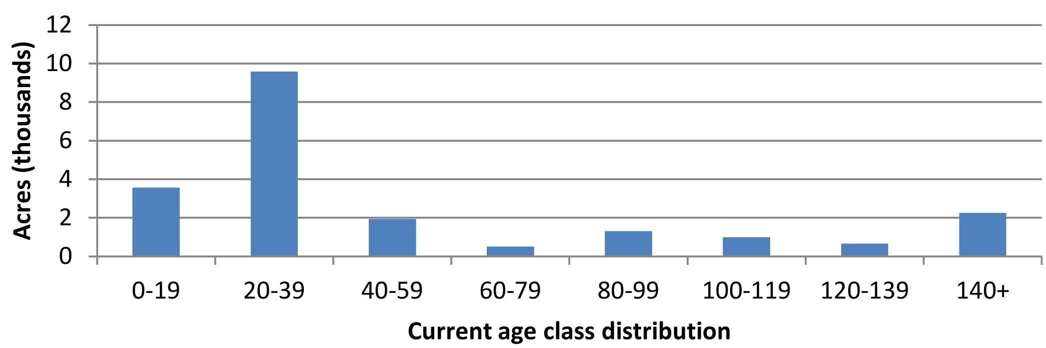


Chart A-53. Age-Class Distribution on State Trust Lands in the Queets Landscape: 30-Year Projection

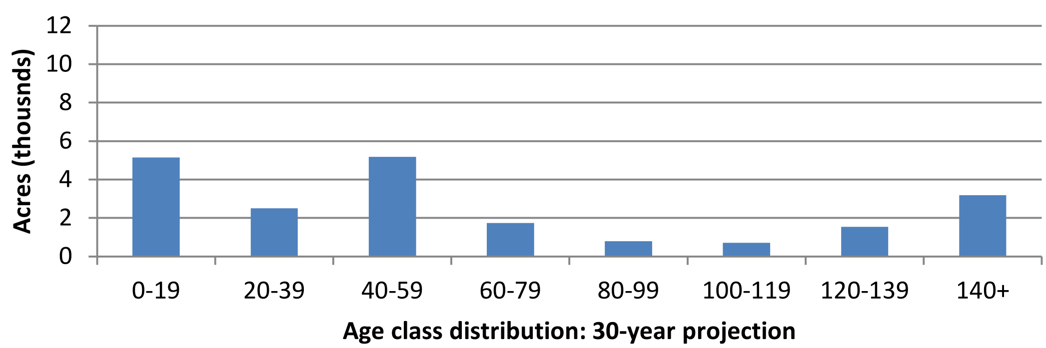
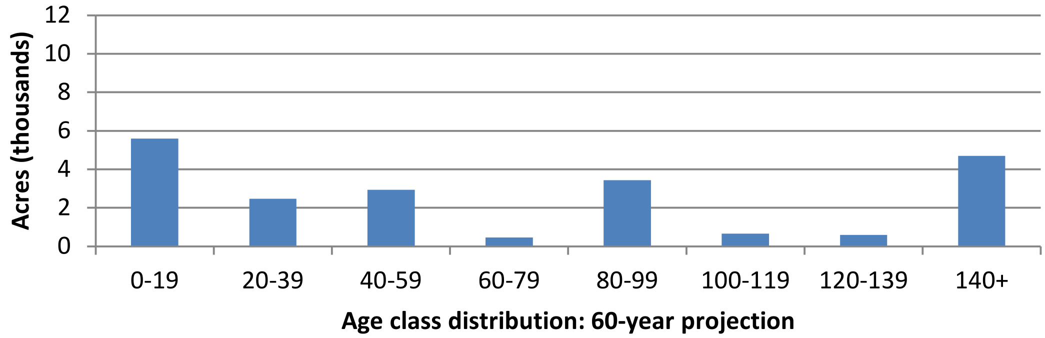


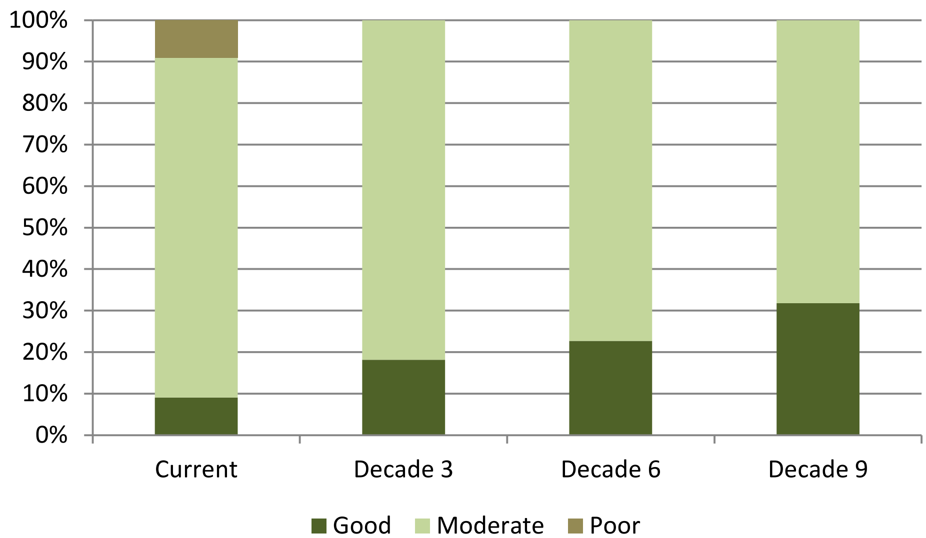
Chart A-54. Age-Class Distribution on State Trust Lands in the Queets Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-55 shows the percent of Type 3 watersheds in the Queets Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-55. Percent of Type 3 Watersheds in the Queets Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The major objectives for the 20,807 Queets Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 8,323 acres (40 percent) of Young Forest Habitat or better, of which
- At least 4,161 acres (20 percent) are Old Forest Habitat.

Chart A-56 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Queets Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-57 and A-58 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-56. Acres of Old and Young Forest on State Trust Lands in the Queets Landscape Over the 100-Year Analysis Period

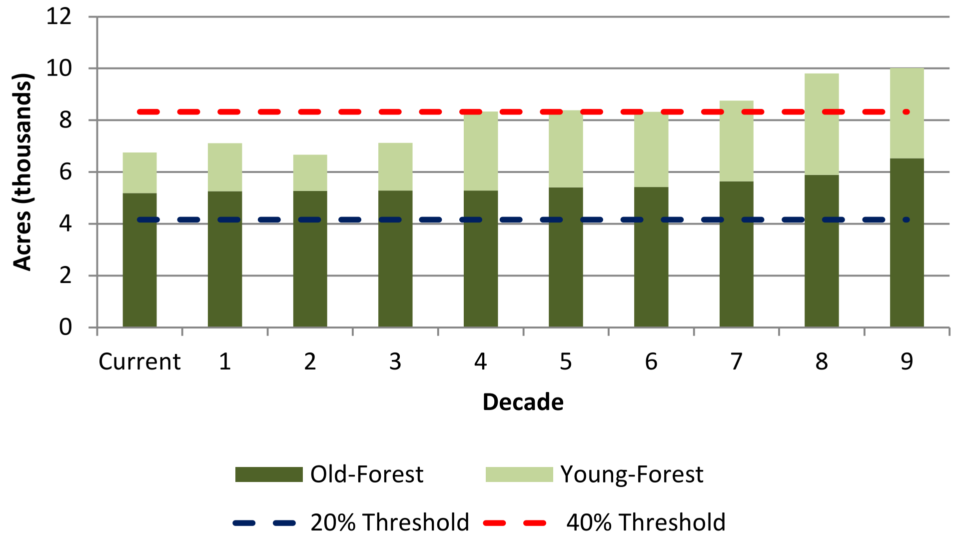


Chart A-57. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Queets Landscape Over the 100-Year Analysis Period

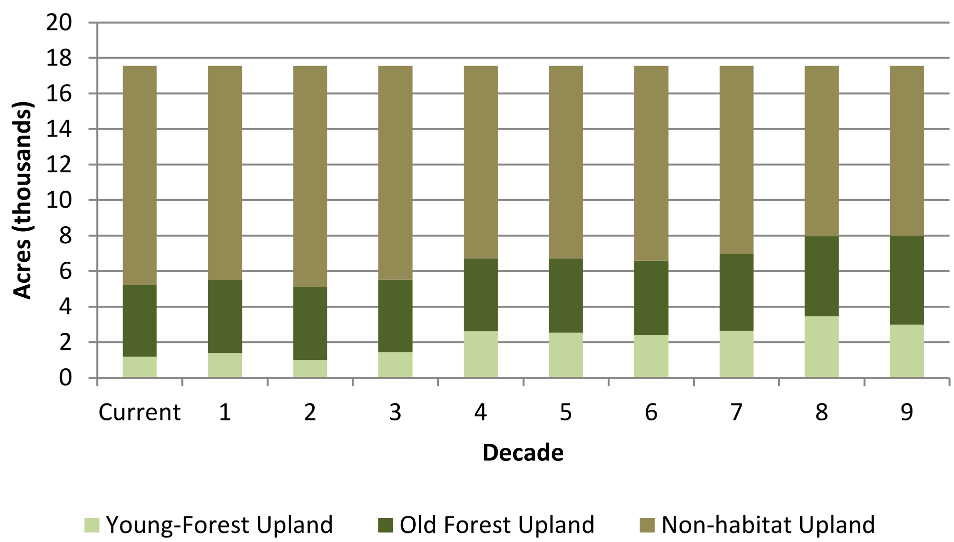
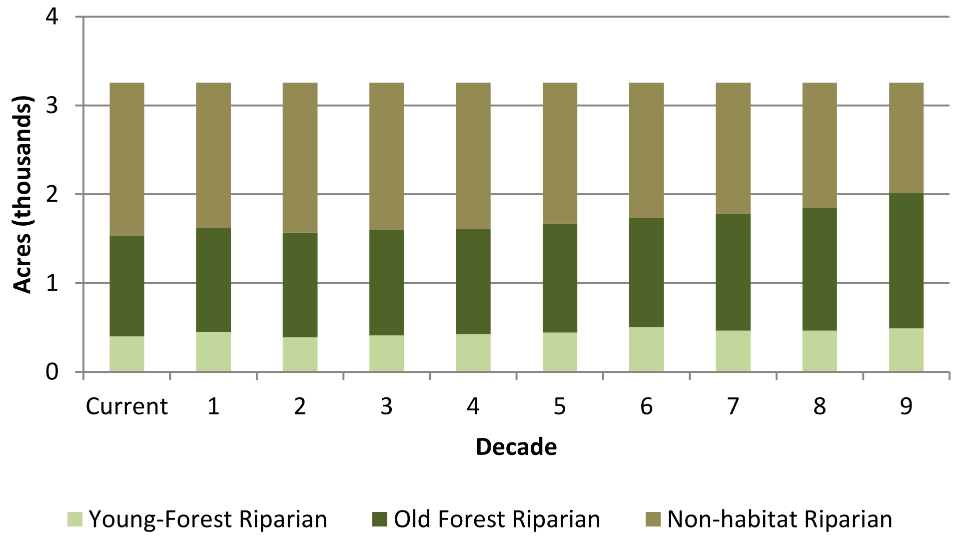


Chart A-58. Northern Spotted Owl Habitat Distribution in the Riparian Land Classification in the Queets Landscape Over the 100-Year Analysis Period



Reade Hill Landscape

Reade Hill is located west of Olympic National Forest mostly in the foothills of the Olympic Mountains between the Bogachiel and Calawah rivers. State trust lands comprise over half of the landscape, with the city of Forks and private forest lands making up the remainder. The predominant forest cover is western hemlock/Douglas-fir plantations, which resulted from the hurricane-force winds of the Great Olympic Blowdown in 1921 (locally known as the "21 Blow").

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-36 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Reade Hill Landscape.

Table A-36. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Reade Hill Landscape

	Acres and percent of total		
Land classification	**Long-term Deferrals**	**Operable**	**TOTAL**
Riparian	2,071 (24%)	397 (5%)	2,468 (29%)
Uplands	2,325 (28%)	3,686 (43%)	6,011 (71%)
TOTAL	**4,396 (52%)**	**4,083 (48%)**	**8,479 (100%)**

HARVEST METHODS AND VOLUMES, DECADE 1

Table A-37 shows the projected number of acres and volume of timber harvested from state trust lands in the Reade Hill Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-37. Harvest Methods and Volumes on State Trust Lands in the Reade Hill Landscape, Decade 1

		Edge density		
	Silvicultural treatment	Low to moderate	Moderate to high	TOTAL
Harvest area (acres)	Variable retention harvest	801	160	961
	Variable density thinning	14	0	14
Harvest volume (MBF)	Variable retention harvest	26,818	5,941	32,758
	Variable density thinning	400	0	400
Total harvest area (acres)		814	160	974
Total harvest volume (MBF)		27,218	5,941	33,159

AGE-CLASS DISTRIBUTION

Chart A-59 shows the current age class distribution of forested acres on state trust lands in the Reade Hill Landscape. Charts A-60 and A-61 show the projected 30- and 60-year age class distributions, respectively.

Chart A-59. Current Age-Class Distribution on State Trust Lands in the Reade Hill Landscape

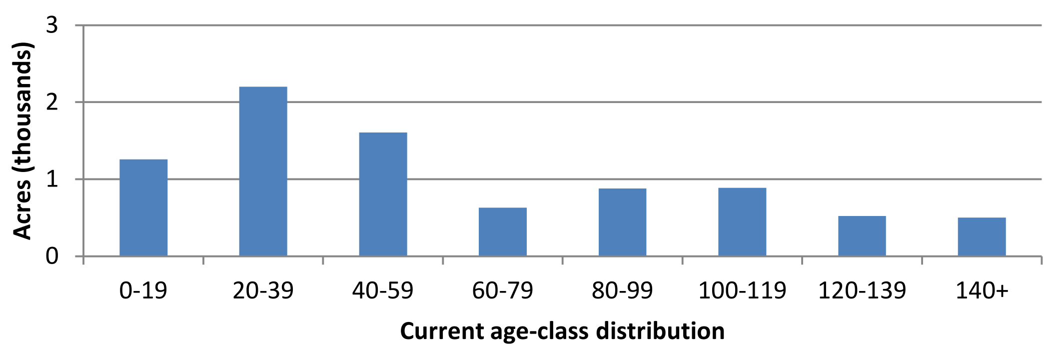


Chart A-60. Age-Class Distribution on State Trust Lands in the Reade Hill Landscape: 30-Year Projection

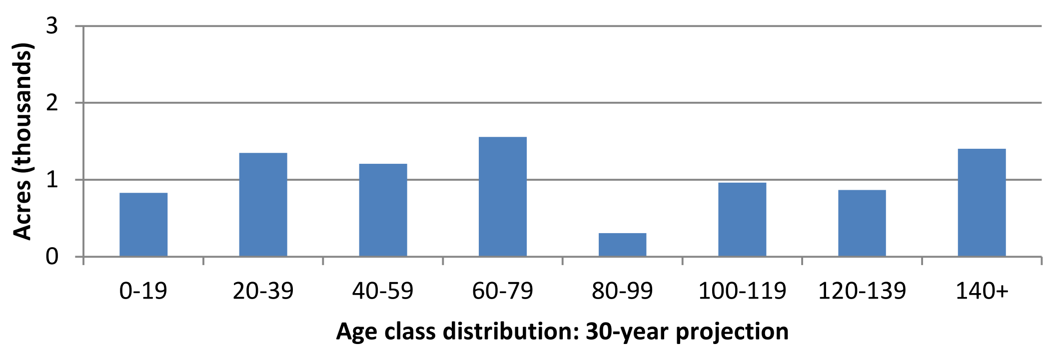
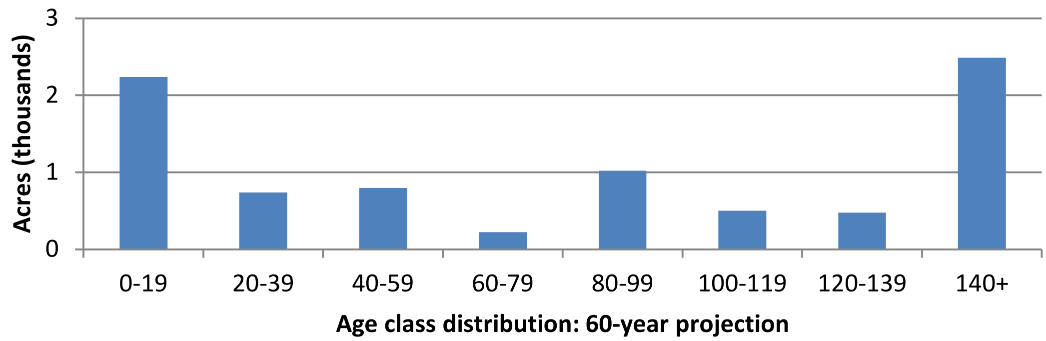


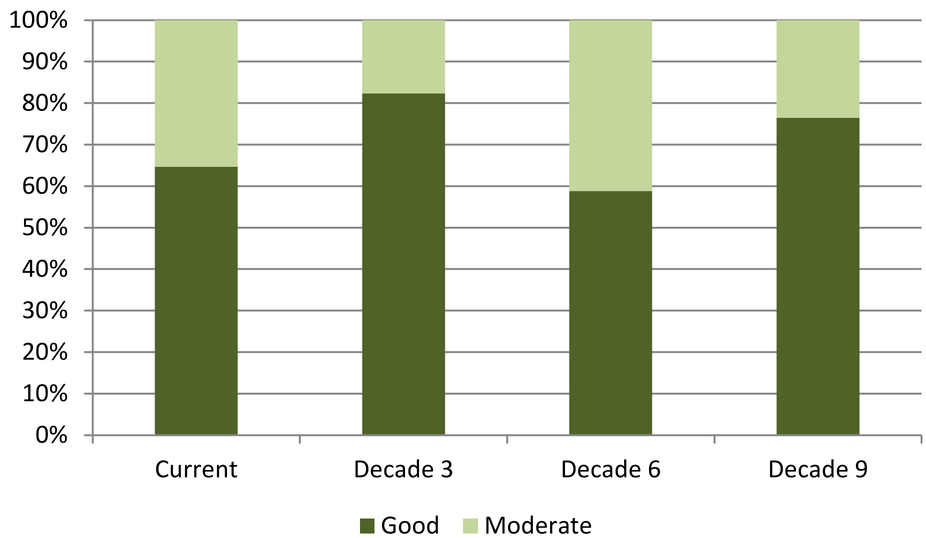
Chart A-61. Age-Class Distribution on State Trust Lands in the Reade Hill Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-62 shows the percent of Type 3 watersheds in the Reade Hill Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-62. Percent of Type 3 Watersheds in the Reade Hill Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The objectives for the 8,479-acre Reade Hill Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 3,392 acres (40 percent)of Young Forest Habitat or better, of which
- At least 1,696 acres (20 percent) are Old Forest Habitat.

Chart A-63 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Reade Hill Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-64 and A-65 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-63. Acres of Old and Young Forest on State Trust Lands in the Reade Hill Landscape Over the 100-Year Analysis Period

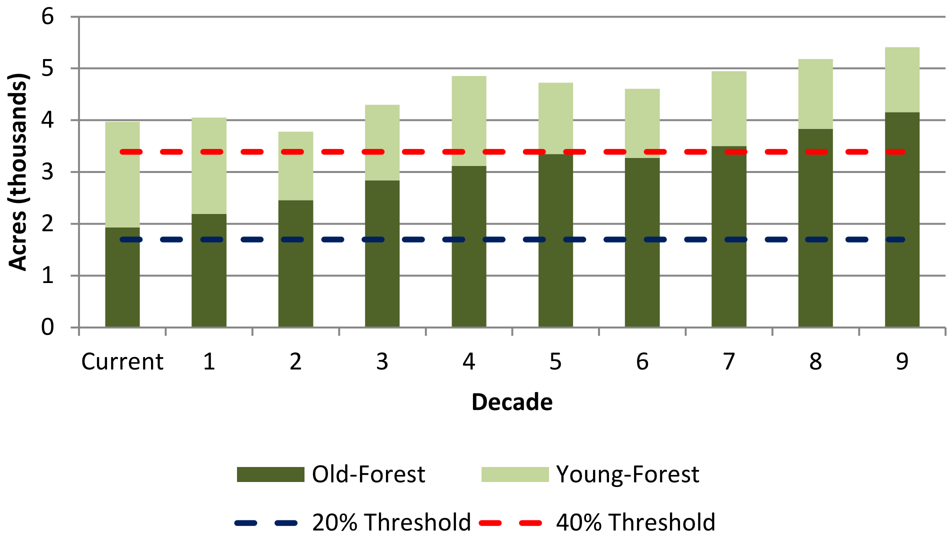


Chart A-64. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Reade Hill Landscape Over the 100-Year Analysis Period

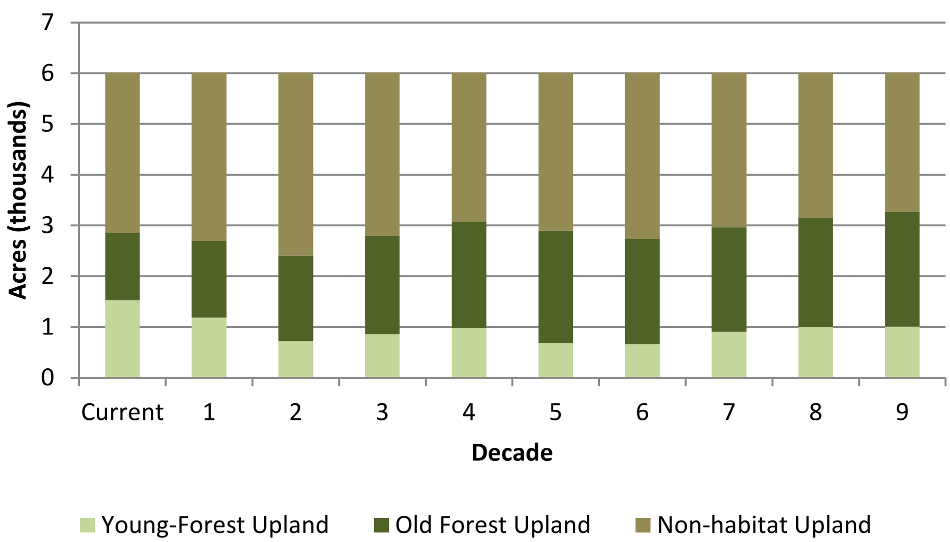
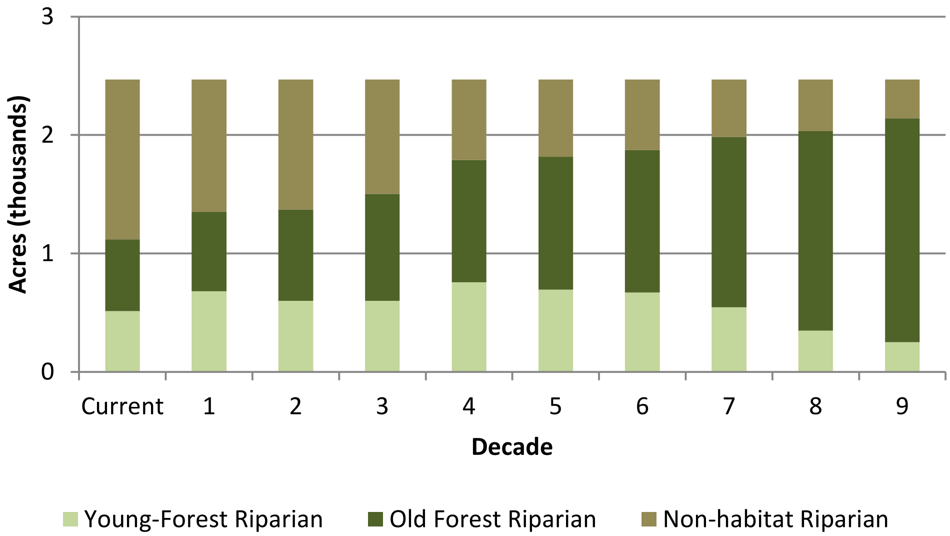


Chart A-65. Northern Spotted Owl Habitat Distribution in the Riparian Land Classification in the Reade Hill Landscape Over the 100-Year Analysis Period



Sekiu Landscape

State trust lands are sparsely scattered across this large landscape, which is composed mostly of private, industrial forest lands in the northwest corner of the Olympic Peninsula. High ridges of the Crescent Formation bisect the landscape, with watersheds to the north draining to the Strait of Juan de Fuca and those to the south draining to the Pacific Ocean.

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-38 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Sekiu Landscape.

Table A-38. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Sekiu Landscape

Land classification	Acres and percent of total		TOTAL
	Long-term deferrals	Operable	
Riparian	1,391 (14%)	547 (5%)	1,938 (19%)
Uplands	414 (4%)	7,662 (77%)	8,076 (81%)
TOTAL	**1,804 (18%)**	**8,210 (82%)**	**10,014 (100%)**

HARVEST VOLUMES AND VOLUMES, DECADE 1

Table A-39 shows the projected number of acres and volume of timber harvested from state trust lands in the Sekiu Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-39. Harvest Method and Volumes on State Trust Lands in the Sekiu Landscape, Decade 1

		Edge density		
	Silvicultural treatment	Low to moderate	Moderate to high	TOTAL
Harvest area (acres)	Variable retention harvest	422	189	611
	Variable density thinning	7	0	7
Harvest volume (MBF)	Variable retention harvest	11,634	5,773	17,407
	Variable density thinning	256	0	256
Total harvest area (acres)		429	189	618
Total harvest volume (MBF)		11,891	5,773	17,663

AGE-CLASS DISTRIBUTION

Chart A-66 shows the current age class distribution of forested acres on state trust lands in the Sekiu Landscape. Charts A-67 and A-68 show the projected 30- and 60-year age class distributions, respectively.

Chart A-66. Current Age-Class Distribution on State Trust Lands in the Sekiu Landscape

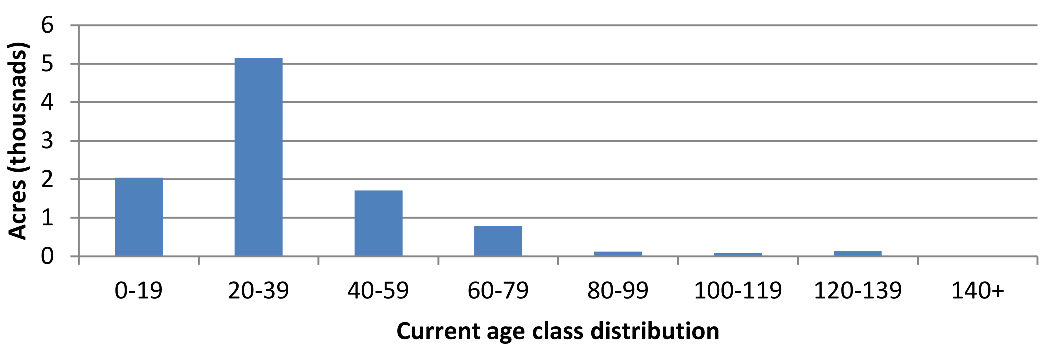


Chart A-67. Age-Class Distribution on State Trust Lands in the Sekiu Landscape: 30-Year Projection

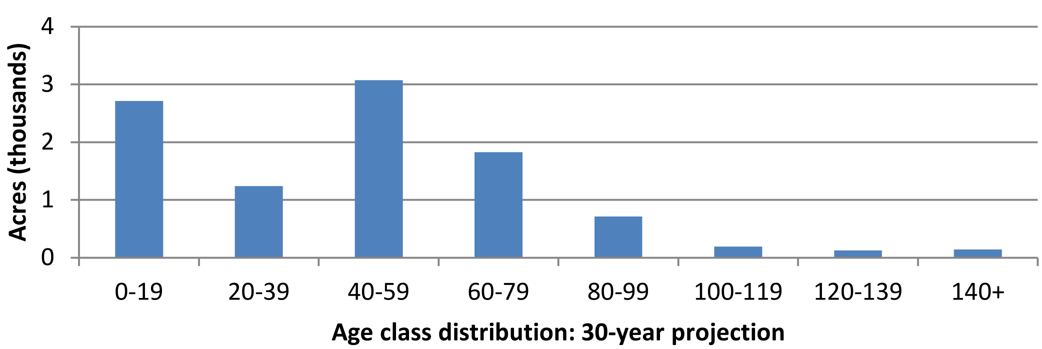
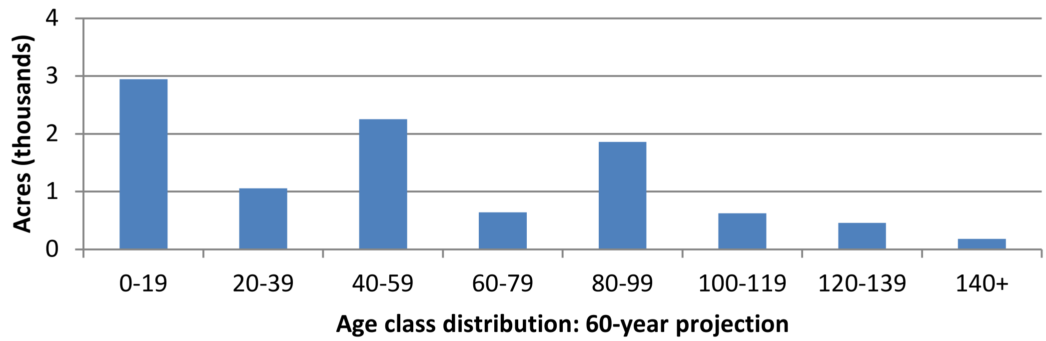


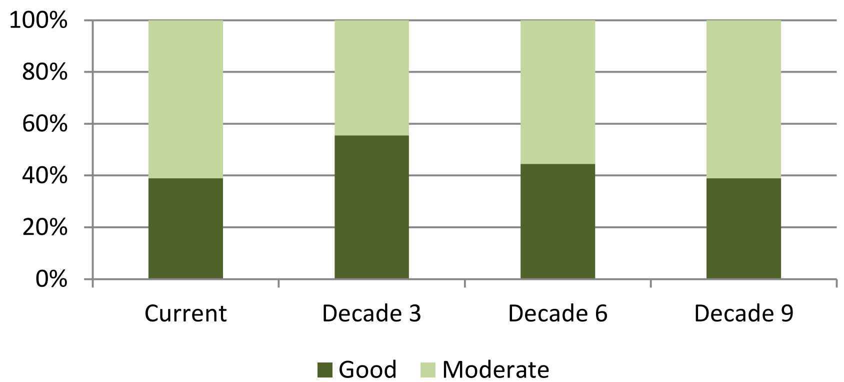
Chart A-68. Age-Class Distribution on State Trust Lands in the Sekiu Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-69 shows the percent of Type 3 watersheds in the Sekiu Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-69. Percent of Type 3 Watersheds in the Sekiu Landscape in a Good, Moderate, or Poor Condition over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The major objectives for the 10,014-acre Sekiu Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 4,006 acres (40 percent) of Young Forest Habitat or better, of which
- At least 2,003 acres (20 percent) are Old Forest Habitat.

Chart A-70 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Sekiu Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-71 and A-72 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-70. Acres of Old and Young Forest Habitat on State Trust Lands in the Sekiu Landscape over the 100-Year Analysis Period

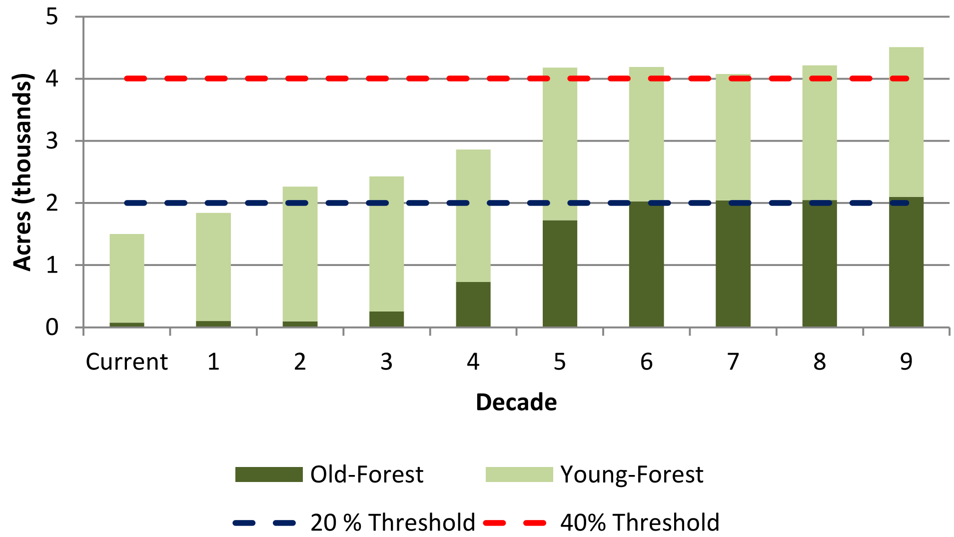


Chart A-71. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Sekiu Landscape Over the 100-Year Analysis Period

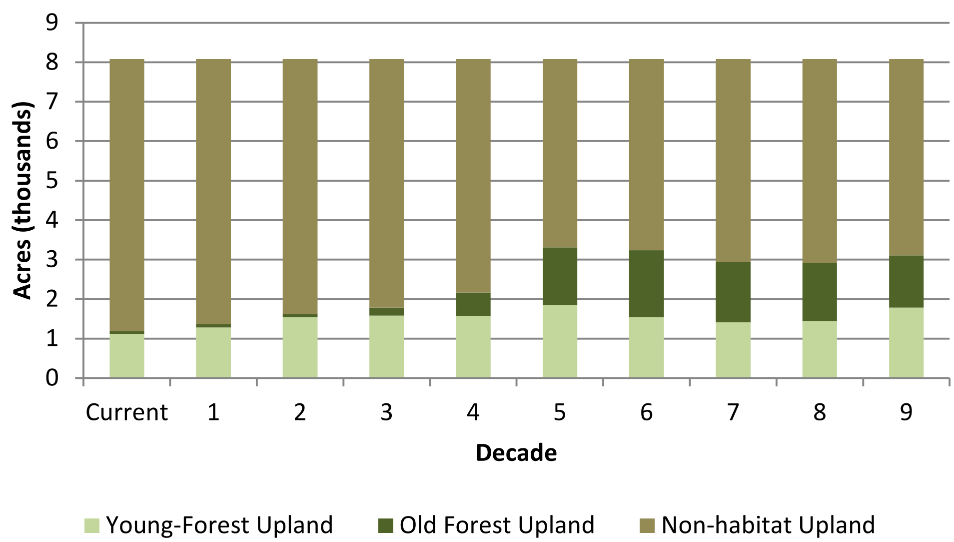
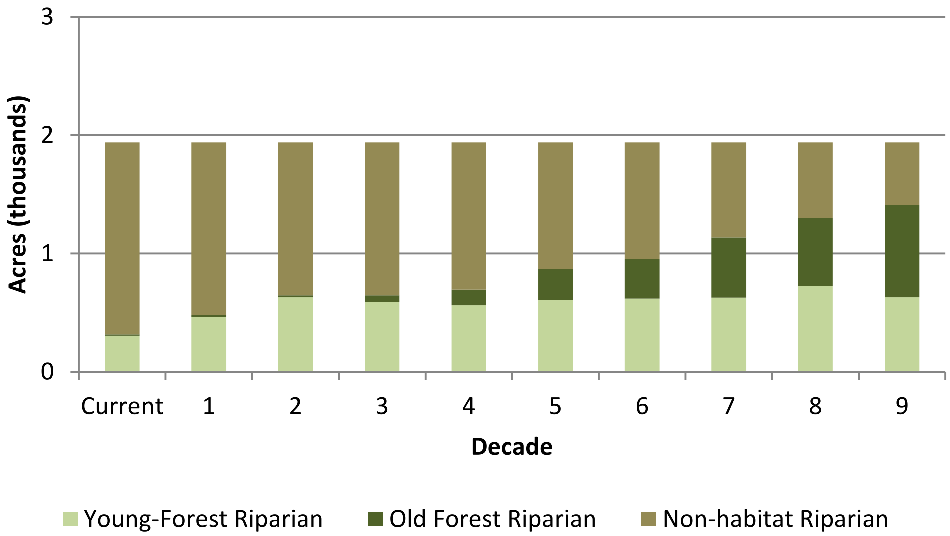


Chart A-72. Northern Spotted Owl Habitat Distribution in the Riparian Land Classification in the Sekiu Landscape Over the 100-Year Analysis Period



Sol Duc Landscape

The Sol Duc Landscape encompasses state trust lands in the Sol Duc River drainage north of the city of Forks and includes a few isolated parcels in the Calawah River basin. The USFS manages most of the higher elevation lands in the Olympic Mountains and on the high ridges of the Crescent Formation in the eastern portion of this large landscape. Private and state trust lands are mostly in the Sol Duc and North Fork Calawah valleys.

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-40 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Sol Duc Landscape.

Table A-40. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Sol Duc Landscape

Land classification	Acres and percent of total		TOTAL
	Long-term deferrals	Operable	
Riparian	2,782 (14%)	1,110 (6%)	3,892 (20%)
Uplands	2,999(16%)	12,255 (64%)	15,254 (80%)
TOTAL	**5,781 (30%)**	**13,365 (70%)**	**19,146 (100%)**

HARVEST METHODS AND VOLUMES, DECADE 1

Table A-41 shows the projected number of acres and volume of timber harvested from state trust lands in the Sol Duc Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-41. Harvest Methods and Volumes on State Trust Lands in the Sol Duc Landscape, Decade 1

		Edge density		
	Silvicultural treatment	Low to moderate	Moderate to high	TOTAL
Harvest area (acres)	Variable retention harvest	2,904	377	3,282
	Variable density thinning	3	0	3
Harvest volume (MBF)	Variable retention harvest	114,826	14,036	128,863
	Variable density thinning	76	1	77
Total harvest area (acres)		2,907	377	3,284
Total harvest volume (MBF)		114,902	14,038	128,940

AGE-CLASS DISTRIBUTION

Chart A-73 shows the current age class distribution of forested acres on state trust lands in the Sol Duc Landscape. Charts A-74 and A-75 show the projected 30- and 60-year age class distributions, respectively.

Chart A-73. Current Age-Class Distribution on State Trust Lands in the Sol Duc Landscape

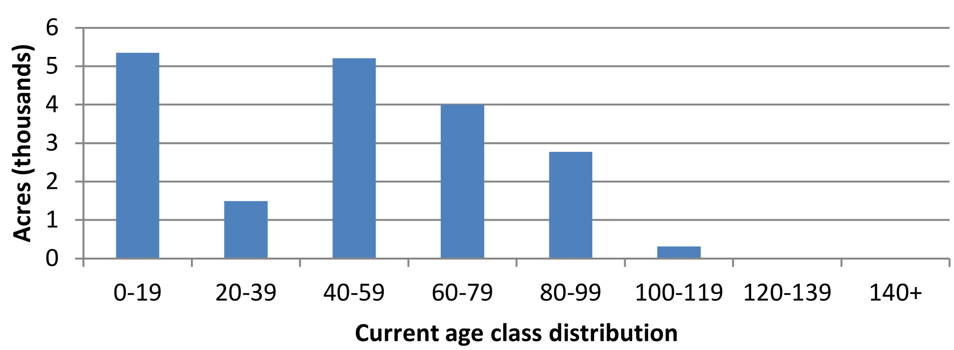


Chart A-74. Age-Class Distribution on State Trust Lands in the Sol Duc Landscape: 30-Year Projection

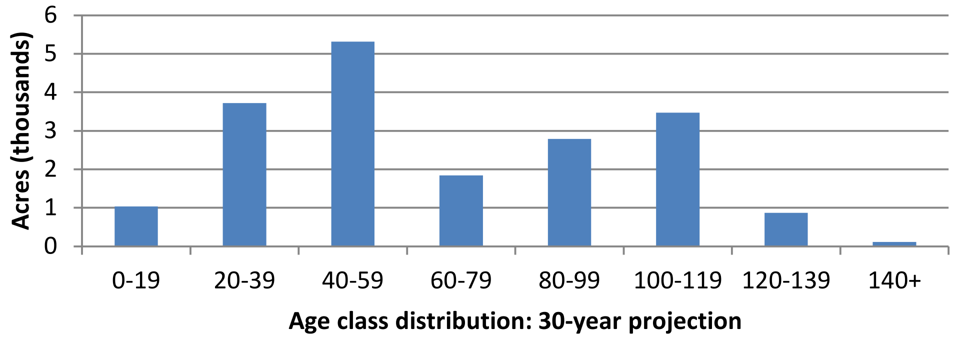
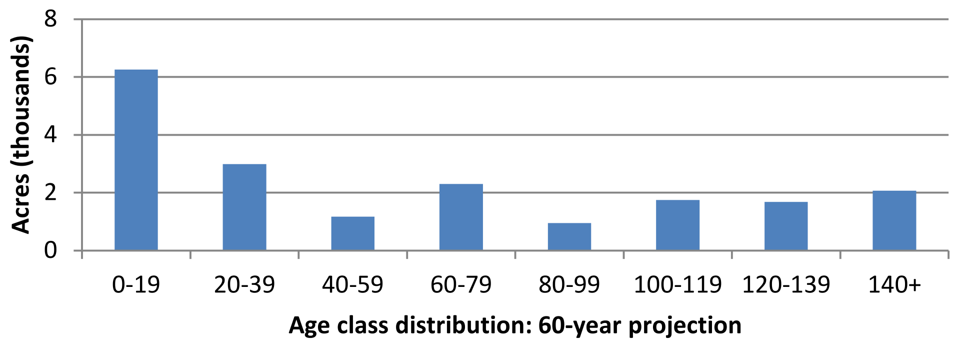


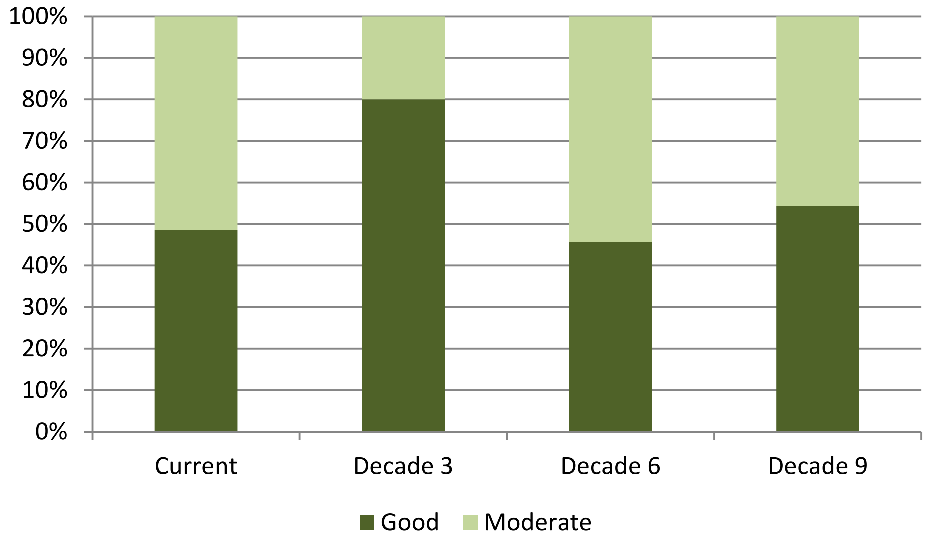
Chart A-75. Age-Class Distribution on State Trust Lands in the Sol Duc Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to “Riparian” in Chapter 3). Chart A-76 shows the percent of Type 3 watersheds in the Sol Duc Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-76. Percent of Type 3 Watersheds in the Sol Duc Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The objectives for the 19,146-acre Sol Duc Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 7,659 acres (40 percent) of Young Forest Habitat or better, of which
- At least 3,829 (20 percent) acres are Old Forest Habitat.

Chart A-77 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Sol Duc Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-78 and A-79 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-77. Acres of Old and Young Foreston State Trust Lands in the Sol Duc Landscape Over the 100-Year Analysis Period

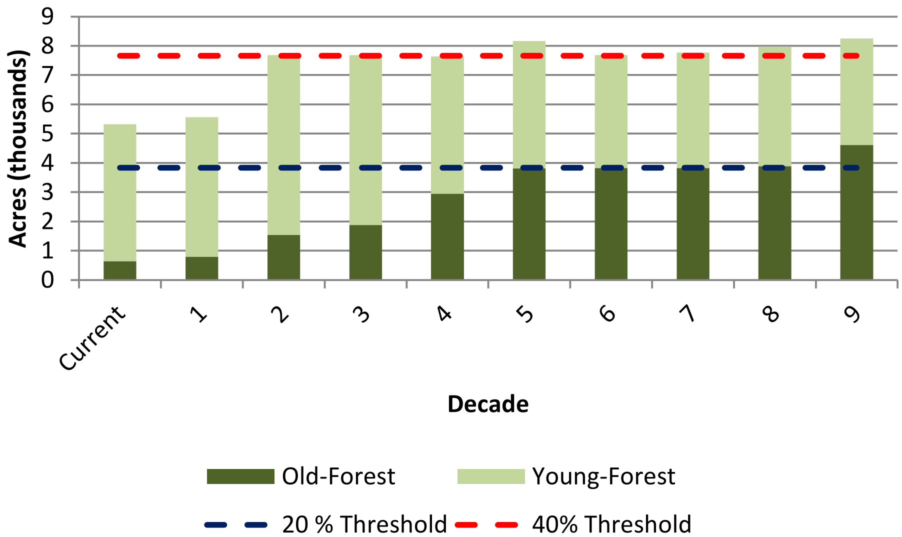


Chart A-78. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Sol Duc Landscape Over the 100-Year Analysis Period

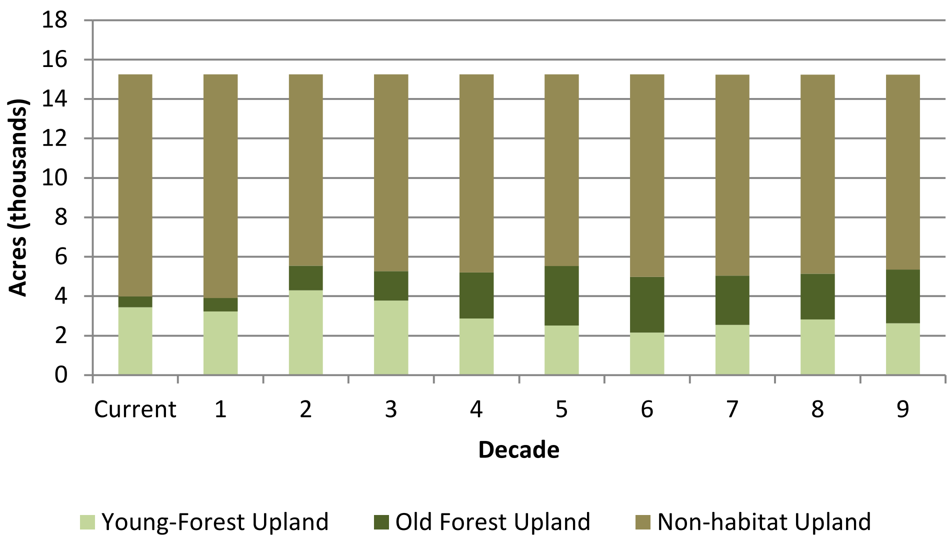
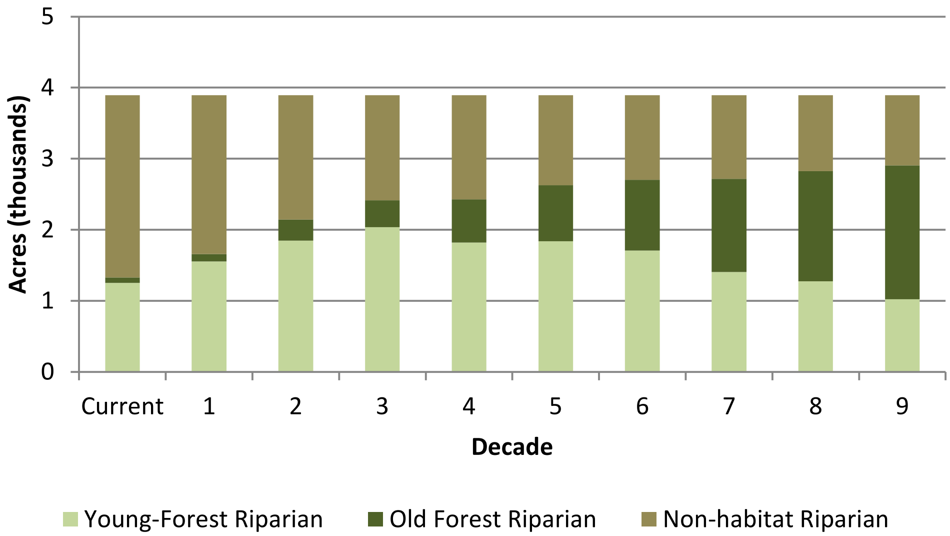


Chart A-79. Northern Spotted Owl Habitat Distribution in the Riparian Land Classification in the Sol Duc Landscape Over the 100-Year Analysis Period



Willy Huel Landscape

The Hoh River runs through the center of this landscape, with the prominent Willoughby, Huelsdonk, and Owl ridges paralleling it along the north and south sides. The ridges encompass the Hoh River valley that starts at 200 feet in elevation and rises to over 3,000 feet at the ridges. The Hoh Valley bottom has meandering river channels with deep soils. Large portions of this landscape have been harvested in the last 40 years, resulting in younger forest conditions. However, approximately 20 percent of the native forest remains, mostly on mid to upper ridges. The north and east sides of the landscape are surrounded by Olympic National Park.

LONG TERM DEFERRALS, OPERABLE AREAS, AND LAND CLASSIFICATION

Table A-42 shows the current acres of long-term deferrals and operable areas by land classification (riparian or upland) on state trust lands in the Willy Huel Landscape.

Table A-42. Acres of Long-Term Deferrals and Operable Areas on State Trust Lands in the Willy Huel Landscape

	Acres and percent of total		
Land classification	**Long-term deferrals**	**Operable**	**TOTAL**
Riparian	11,084 (30%)	1,897 (5%)	12,981 (35%)
Uplands	7,630 (20%)	16,817 (45%)	24,446 (65%)
TOTAL	**18,714 (50%)**	**18,714 (50%)**	**37,428 (100%)**

HARVEST METHODS AND VOLUMES, DECADE 1

Table A-43 shows the projected number of acres and volume of timber harvested from state trust lands in the Willy Huel Landscape by harvest method during the first decade of the draft OESF forest land plan.

Table A-43. Harvest Methods and Volumes on State Trust Lands in the Willy Huel Landscape, Decade 1

	Silvicultural treatment	Edge density: Low to moderate	Edge density: Moderate to high	TOTAL
Harvest area (acres)	**Variable retention harvest**	2,458	831	3,289
	Variable density thinning	0	0	0
Harvest volume (MBF)	**Variable retention harvest**	50,724	16,360	67,084
	Variable density thinning	0	1	1
Total harvest area (acres)		2,458	831	3,289
Total harvest volume (MBF)		50,724	16,361	67,085

AGE-CLASS DISTRIBUTION

Chart A-80 shows the current age class distribution of forested acres on state trust lands in the Willy Huel Landscape. Charts A-80 and A-82 show the projected 30- and 60-year age class distributions, respectively.

Chart A-80. Current Age-Class Distribution on State Trust Lands in the Willy Huel Landscape

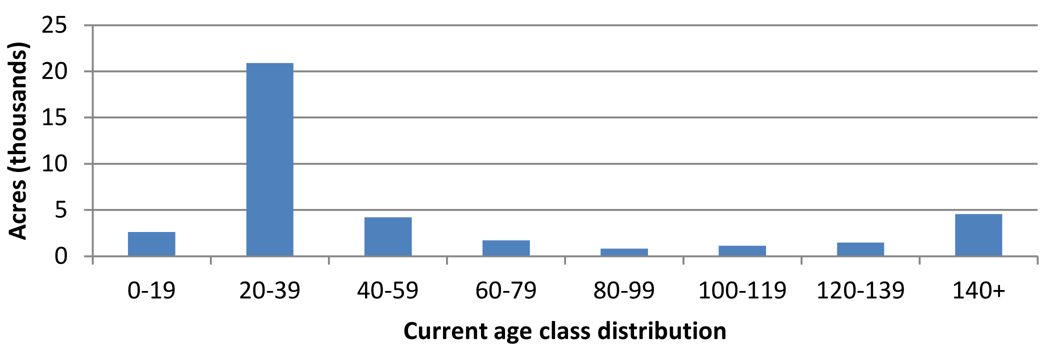


Chart A-81. Age-Class Distribution on State Trust Lands in the Willy Huel Landscape: 30-Year Projection

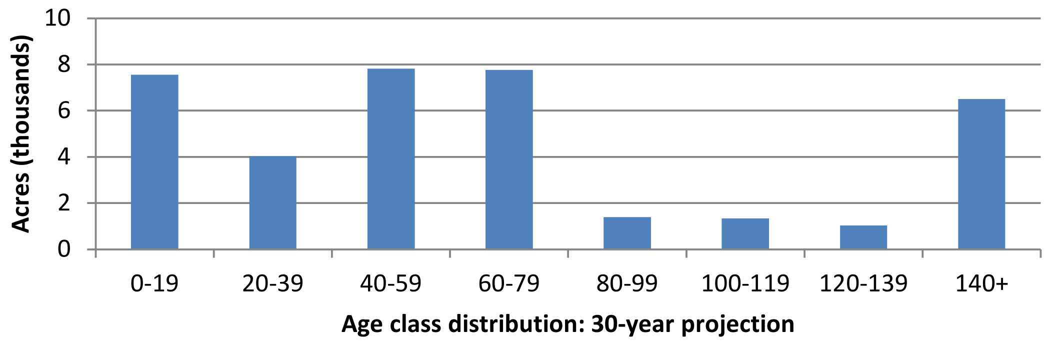
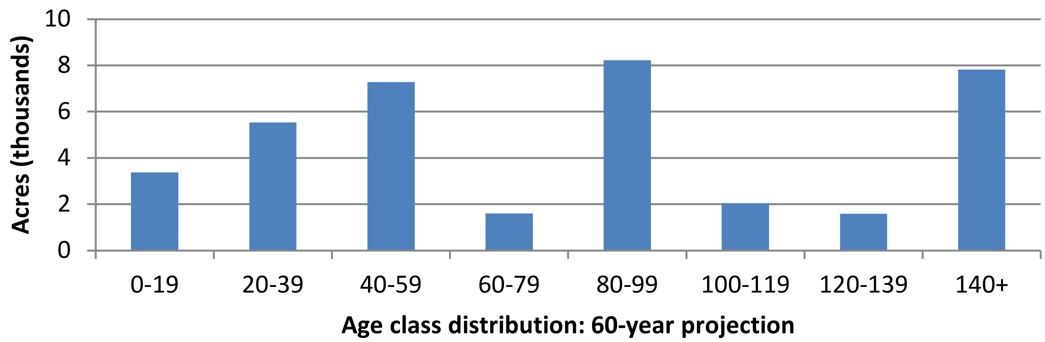


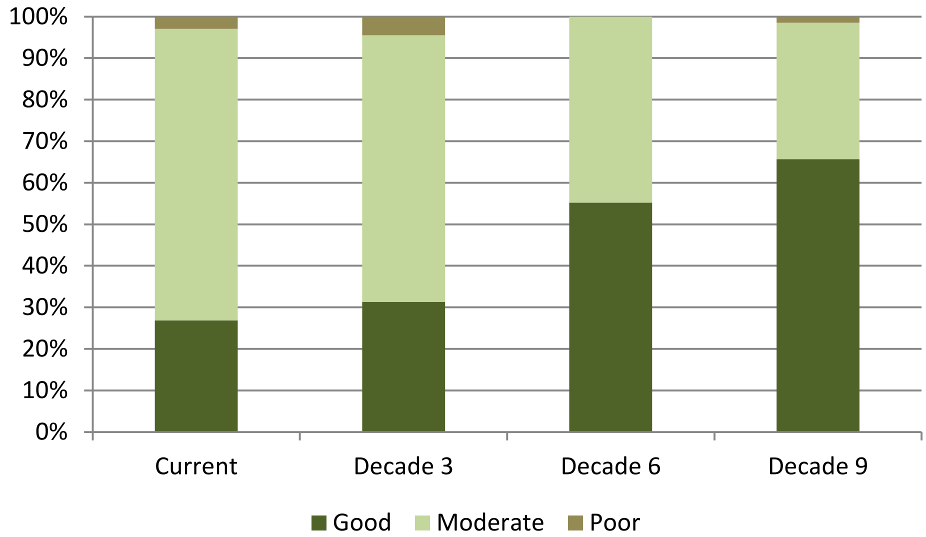
Chart A-82. Age-Class Distribution on State Trust Lands in the Willy Huel Landscape: 60-Year Projection



RIPARIAN FUNCTION

In the OESF RDEIS, DNR assessed riparian indicators at the Type 3 watershed scale, not at the landscape scale. The RDEIS analysis indicated a gradual improvement in riparian function (refer to "Riparian" in Chapter 3). Chart A-83 shows the percent of Type 3 watersheds in the Willy Huel Landscape in a good, moderate, or poor condition over the 100-year analysis period.

Chart A-83. Percent of Type 3 Watersheds in the Willy Huel Landscape in a Good, Moderate, or Poor Condition Over the 100-year Analysis Period



NORTHERN SPOTTED OWL HABITAT THRESHOLDS

The objectives for the 37,428-acre Willy Huel Landscape to meet or exceed the minimum thresholds for northern spotted owl habitat are:

- At least 14,971 acres (40 percent) of Young Forest Habitat or better, of which
- At least 7,486 acres (20 percent) are Old Forest Habitat.

Chart A-84 shows the existing and projected acres of state trust lands in Old and Young Forest Habitat in the Willy Huel Landscape. The dotted lines indicate the 20 percent and 40 percent minimum habitat thresholds. Charts A-85 and A-86 show the existing and projected acres of state trust lands that are Old and Young Forest Habitat in the upland and riparian land classifications, respectively.

Chart A-84. Acres of Old and Young Forest on State Trust Lands in the Willy Huel Landscape Over the 100-Year Analysis Period

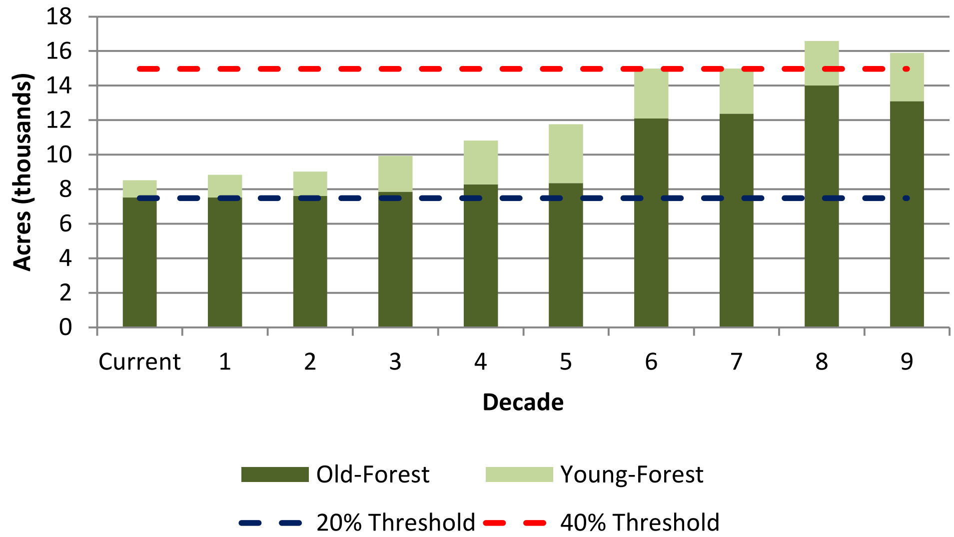


Chart A-85. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Willy Huel Landscape Over the 100-Year Analysis Period

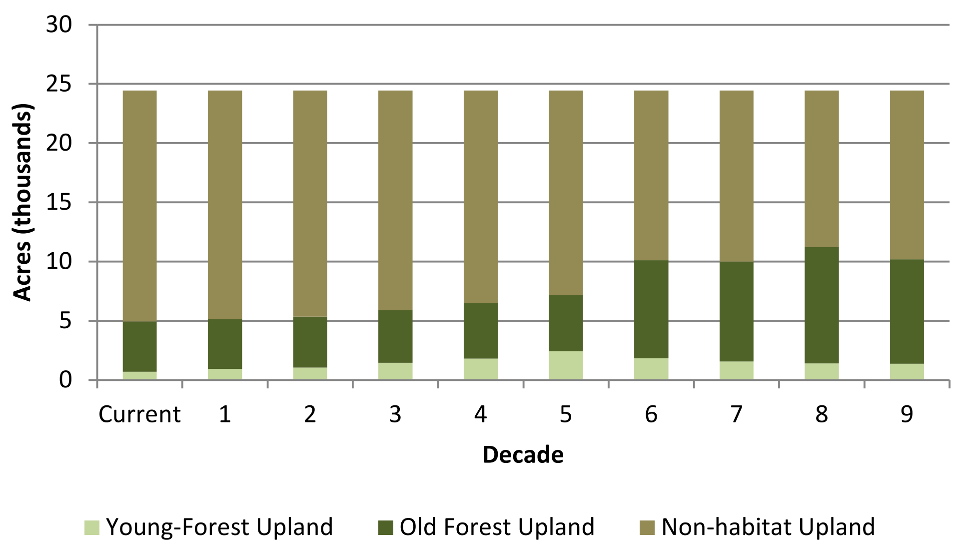
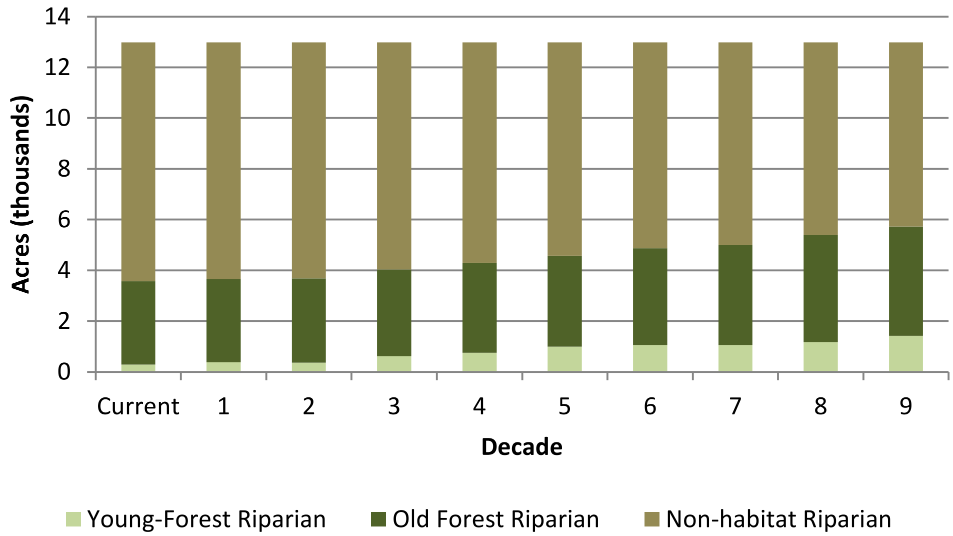


Chart A-86. Northern Spotted Owl Habitat Distribution in the Upland Land Classification in the Willy Huel Landscape Over the 100-Year Analysis Period



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[1] Openings larger openings than 5 acres in size or that have a rotation objectives for the regenerated cohort should be designated as new FMUs.

[2] "May 2007 Board Presentation on Sustainable Harvest Level Adjustment" found on http://www.dnr.wa.gov/BusinessPermits/Topics/SustainableHarvestImplementation/Pages/lm_sust_harvest_implement.aspx

[3] This ownership threshold is used to identify areas where DNR manages enough of the watershed that its management practices could influence watershed conditions. The use of such a threshold followed recommendations from federal watershed monitoring programs (Reeves and others 2004, Gallo and others 2005).

[4] DNR classifies state trust lands as either "riparian" or "uplands" in the forest estate model. These classifications are used in this forest land plan to demonstrate changes in ecological conditions; however, these land classifications are not used for management. The riparian land classification should not be confused with riparian management zones and does not reflect the total number of acres that will be located within riparian management zones.

[5] Natural Resource Conservation Areas (NRCA) are areas set aside to protect native plants, plant communities and animals, and for use as outdoor classrooms for environmental education and scientific research. NRCAs often include significant geologic features, archaeological resources, or scenic attributes. NRCAs often have developed public access facilities.

Chapter 4

Research, Monitoring, and Adaptive Management

In this chapter of the draft forest land plan, DNR describes its concept of adaptive management and how adaptive management will be conducted in the OESF using information from monitoring, research, and operations. DNR also provides an initial list of key uncertainties identified in the forest land planning process and describes how these uncertainties will be linked to adaptive management questions and specific research and monitoring activities. In addition, DNR lists priority research and monitoring activities to be implemented in the near term (within approximately five years).

Introduction

Managing in the Face of Uncertainty: Three Approaches

Uncertainties (refer to Text Box A-11) are an inherent and pervasive feature of managing natural resources because available knowledge is often limited. In the face of uncertainty, land managers such as DNR must often find a way to continue managing natural systems to reach their land management objectives. There are three general approaches to managing in the face of uncertainty: adaptive management, a precautionary approach, and trial and error. In the following section, DNR will describe each approach and explain which approaches will be used in the OESF.

Text Box A-11. Key Terms Used in This Chapter

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 science, absolute certainty is rare, so scientific uncertainty is defined as how well something is known. In this chapter the following terms are used interchangeably: *uncertainty, incomplete information,* and *limited knowledge.*

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.

Risk: The chance of loss or harm.

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.

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

What Is Adaptive Management?

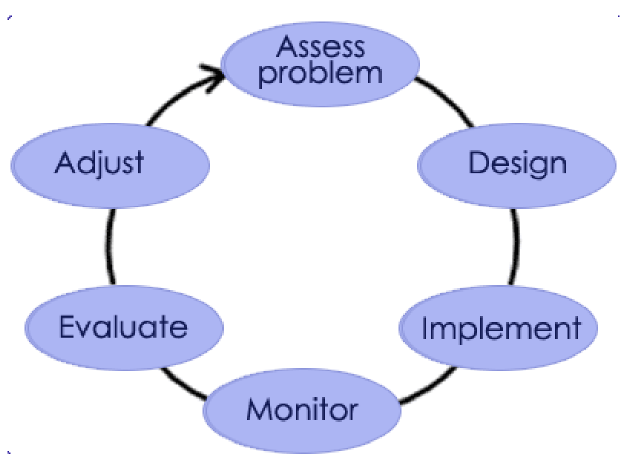
Adaptive management was conceived in the 1970s and 1980s (Holling 1978; Walters 1986) as a way to manage natural resources when knowledge of ecosystem functions or the effects of human action is incomplete. Adaptive management has been defined in the literature in many different ways. DNR has selected 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 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 (refer to Figure A-6). A modified version of this cycle will be used later in this chapter to describe DNR's adaptive management process (refer to Figure A-8).

Figure A-6. Conceptual Diagram of the Adaptive Management Process

Diagram used in the United States Department of the Interior's Adaptive Management Technical Guide



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, one of the management objectives is to obtain information that increases confidence in ongoing management or provides alternative management solutions. Text Box A-11 summarizes the key characteristics of adaptive management.

Text Box A-11. Key Characteristics of Adaptive Management

Summarized from abundant scientific literature including Stankey and others 2005, Williams and others 2007

- Learning is triggered by the explicit acknowledgement of risk and uncertainties about the response of a particular system to management actions. Reducing these uncertainties (i.e. learning) becomes one objective of adaptive management.
- It is an intentional learning process 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 advanced, is used to close the loop between gathered information and management decisions.
- Multiple iterative steps are used to ensure that improvement is continuous.

It is a science-informed process in which the implications of management adjustments are clearly understood.

What Are the Precautionary and Trial and Error Approaches?

The precautionary and trial and error approaches are alternatives to adaptive management.

- **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 or restricting activities in specific areas, such as potentially unstable slopes, until more information is collected to elucidate key processes and relationships. Forty-three percent of the OESF, or 110,823 acres, is currently in this status, referred to in the OESF as long-term deferral. Many long-term deferrals, such as Old Forest Habitat and marbled murrelet occupied sites, were established after the adoption of the 1997 HCP. These long-term deferrals are designed to alleviate potential ecological harm. At the same time, they also reduce revenue, provide little opportunity for learning, and in some cases, preclude 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 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).

Why Choose Adaptive Management?

Multiple considerations—regulatory, social, economic, and ecological—play a role in the selection of the adaptive management approach over other management 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[2] 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. Although DNR will continue applying the precautionary approach and trial and error approach in some areas, DNR will also continue to pursue an adaptive management approach for the OESF, for two reasons. First, this approach conforms to the original OESF vision adopted as part of the 1997 HCP 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). Combining two potentially competing management objectives (commodity production [revenue generation] and ecological values) across state trust lands in the OESF and dealing with uncertainties inherent to all natural systems argues for managing the OESF experimentally and learning from it. Second, 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).

Adaptive Management and the 1997 HCP

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]).

The 1997 HCP embraced adaptive management for the OESF: the "systematic application of knowledge gained" is one of the six management processes recommended for the OESF. The 1997 HCP also described "a process of integrating intentional learning with management decision making and course adjustments" as an important component of the experimental approach (DNR 1997, p. I.15). In addition, the 1997 HCP specified information-gathering activities as the basis for adaptive management and listed priorities and topics for research (DNR 1997, p. V.1 through V.9). Finally, the 1997 HCP Implementation Agreement listed specific adaptive management practices to be implemented by DNR (DNR 1997, p. B.10 through B.11).

Adaptive Management in the OESF

In the following section, DNR describes its past attempts to implement adaptive management, the current focus of adaptive management in the OESF, the types of adaptive management that will be used, and the adaptive management process.

History of Research, Monitoring, and Adaptive Management in the OESF

DNR first defined research and monitoring and adaptive management in 1991 when it prepared the draft 1991 OESF Management Plan (1991 Plan). This plan provided broad guidance for selecting research activities and implementing adaptive management. As explained in Chapter 1, the plan was neither finalized nor adopted.

A number of research and monitoring projects have taken place in the OESF since its status as an experimental forest was confirmed in 1992 (for a list of projects, refer to the OESF Research and Monitoring Catalog [Teply and Phifer 2008]). Some of these projects were funded and conducted by DNR; others were implemented through research partnerships such as silvicultural research cooperatives. Despite a track record of research and monitoring activities over the years, DNR has found it challenging to demonstrate a clearly defined, structured decision-making process for adapting management in response to new information.

Another effort to address experimentation in the OESF programmatically was made in 2001 when DNR science staff developed a strategic research and adaptive management plan and several monitoring plans for HCP-covered lands. The OESF research and monitoring priorities were identified together with the priorities for other HCP planning units. These plans were approved by the Federal Services as fulfilling HCP commitments but were not officially adopted and fully implemented by DNR. The main reason was a reduction of DNR's budget due to the 2000-2001 financial downturn, resulting in elimination of staff and reduction of project funding.

DNR started re-building the OESF Research and Monitoring Program in 2006. These efforts included establishing the OESF Research and Monitoring Manager position, developing a draft OESF Research and Monitoring Strategy (Teply 2009), and participating in a national network of experimental forests and ranges (Memorandum of Understanding between USFS and DNR signed August 25, 2009). Despite these efforts, the program was insufficiently funded because of the 2009 Great Recession.

Current efforts to address adaptive management in the OESF, which have occurred as part of this forest land planning process, included a comprehensive review of DNR's current information needs and development of a process to address them in a programmatic fashion, linking information gathering activities to future management decisions, and institutionalizing the adaptive management process through a procedure.

DNR has begun implementing status and trends monitoring of riparian and aquatic habitat (refer to "Priority Research and Monitoring Activities in the Near-Term" later in this chapter) and information management (refer to Appendix A-1) and is strengthening partnerships with research organizations such as the USFS Pacific Northwest Research Station.

Several applied research projects, prompted by the knowledge gaps identified during the planning process, are currently underway. For example, DNR is developing a synthetic GIS layer for identifying and typing streams and modeling road management decisions with harvest decisions.

Focus of Adaptive Management

The adaptive management process in the OESF will focus on finding better ways to integrate revenue production and ecological values in the OESF. Specifically, the process will focus on the uncertainties associated with forest management as proposed in this draft forest land plan. These uncertainties will be reduced through research and monitoring. The knowledge gained 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 was defined earlier in this chapter as a science-informed process. DNR acknowledges that political, social, and economic realities also are expected to affect decision-making at key steps in the process (Steps 1, 6 and 7 in Figure A-7 later in this chapter). For example, when making decisions, DNR must consider its fiduciary responsibility as a trust land manager, as well as its responsibilities per the 1997 HCP, 2006 PSF, and other policy documents. An adaptive management process that doesn't respect these realities is likely to be overly idealized and probably unrealistic.

Changes in management will not be derived solely from the adaptive management process. Natural disturbances such as catastrophic winds or fire, or political, social, or economic factors may also prompt changes in forest management practices. However, DNR considers changes prompted solely by these factors to be outside the adaptive management process.

What Types of Adaptive Management Will Be Used?

DNR will use 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.

  Passive adaptive management will be used most often in the OESF in the near term. DNR will focus on monitoring the management strategies described in this draft forest land plan.

- 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. Management actions are part of a formal experimental or quasi-experimental[3] design to best understand cause-effect relationships. Active adaptive management yields higher-quality information in less time, but at a greater short-term cost, than passive management. An example of active adaptive management envisioned for the OESF is silvicultural experimentation to restore and maintain structurally complex forest (refer to "Priority Research and Monitoring Activities in the Near-Term" 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 NMFS 2000).

Note that management alternatives were explored through modeling and environmental analyses as part of this forest land planning process, which is a standard practice for most of DNR's planning projects. The results of these credible and deliberate efforts may be considered in future adaptive management discussions; however, they are not considered a step of a formal adaptive management process. The formal adaptive management process aims to improve the management practices that are implemented, i.e. the preferred alternative selected through this forest land planning process.

Sources of Information for Adaptive Management in the OESF

The Role of Research and Monitoring

A science-informed adaptive management relies primarily on research and monitoring to provide new, relevant 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:

> "[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" (USFWS and NMFS 2000) (brackets added).

If an HCP has an adaptive management provision, as is the case with DNR's 1997 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).

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).

For a discussion about the types of monitoring to be used in the OESF, refer to Step 3 of the adaptive management process later in this chapter.

Research and monitoring are most effective at improving management practices when implemented in an adaptive management context. However, not all research and monitoring activities have to be part of a formal adaptive management process. 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 improvement of natural resource management. In other words, the information they produce likely will have relatively minor or indirect influence on management decisions.

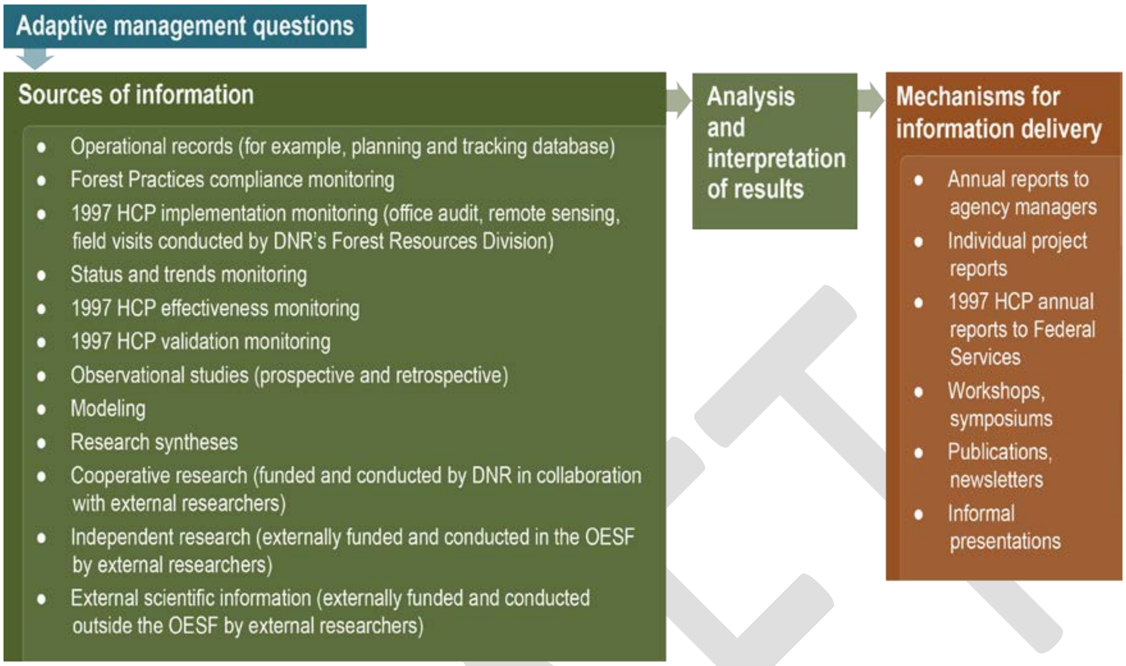
The Role of Other Information Sources

Along with Lindenmayer and Franklin (2002) and other authors, DNR supports the position that relevant knowledge for adaptive management can be acquired from a variety of sources including research, monitoring, modeling (for example, windthrow probability model), and operations (for example, placement of exterior buffers in riparian areas). DNR views routine management operations and management experience as an important source of information for adaptive management. Under this holistic approach, recommendations for adaptive management are made after interpreting a range of information sources (refer to Figure A-7).

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).

DNR will use 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 1997 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).

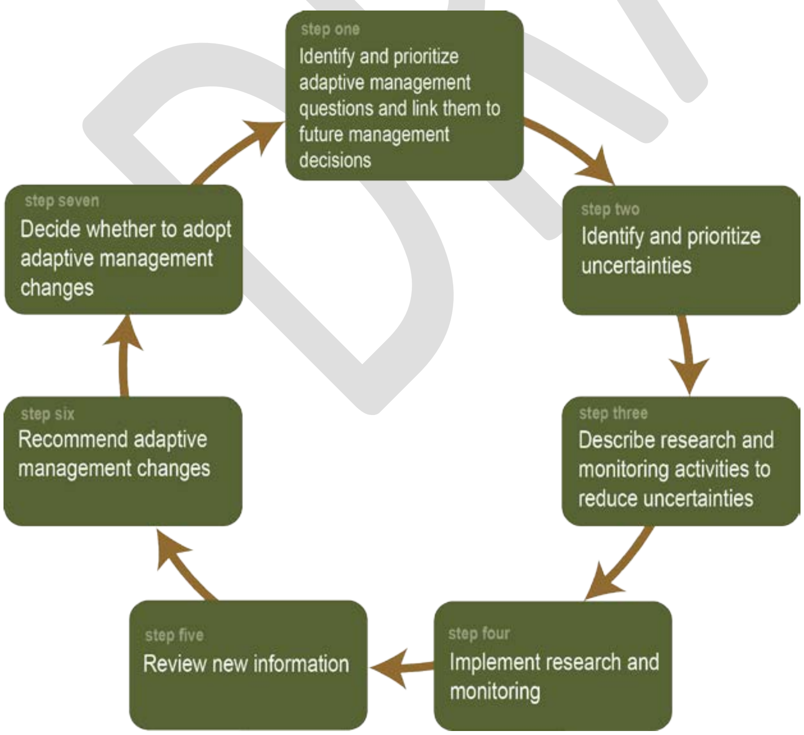
Figure A-7. Information Sources and Mechanisms for Information Delivery



The Adaptive Management Process

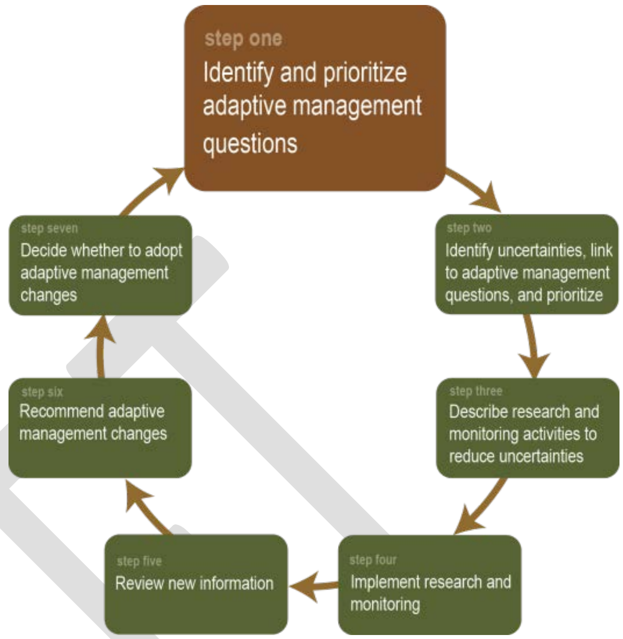
The adaptive management process in the OESF is based on the conceptual model presented in Figure A-8.[4] In the following section, DNR will explain each step of this process.

Figure A-8. Adaptive Management Process in the OESF



Step 1, Identify and Prioritize Adaptive Management Questions

IDENTIFY ADAPTIVE MANAGEMENT QUESTIONS



DNR begins Step 1 by identifying adaptive management questions. These questions are related to improving the integration of revenue production and ecological values, and are based on the management strategies described in Chapter 2 of this draft forest land plan. DNR envisions these questions as the starting point of an adaptive management process. Beginning the adaptive management process with the key adaptive management questions instead of the question "What don't we know?" will help maintain a keen focus on management needs.

DNR's management strategies are based on working hypotheses. Working hypotheses are based on the best available science, professional judgment, and experience, and are conditionally accepted ways to proceed with management when faced with uncertainty. For example, one working hypothesis is that protecting wetlands with buffers and special management considerations is sufficient to prevent loss of net wetland acreage and function. The strategy based on this hypothesis is to protect wetlands.

The recognition that adopted management approaches, from the level of the large regional plan to specific management prescriptions for a single, local project, are working hypotheses is central to resource management (Lindenmayer and Franklin 2002). Stating those hypotheses explicitly helps formulate adaptive management questions, which in turn creates focus for research and monitoring activities.

The "underlying hypothesis" (term used in the 1997 HCP) or rather the conceptual basis for management in the OESF is that "It is possible to produce quality commercial timber and provide and protect ecological values in a managed forest by maintaining an arrangement of forest structure and stand diversity" (DNR 1997, p. IV.83). The OESF was designated in part to be a testing ground for innovative forest practices to achieve the integration of revenue production and ecological values.

Examples of the relationships between working hypotheses and their associated management strategies are summarized in Charts A-87 and A-88 for the riparian and the northern spotted owl conservation strategies. As DNR implements adaptive management, it expects to develop similar relationships between working hypotheses and management strategies for revenue generation, forest growth and development, and marbled murrelets.

Chart A-87. Links between Working Hypotheses and Management Strategies for Riparian Habitat

Main management issue

How to harvest timber near streams and wetlands in a way that aids restoration and maintenance of riparian functions such a bank integrity, shade, large woody debris, and hydrologic response.

*DNR will manage under the following **primary working hypothesis:***

Primary working hypotheses

Riparian conservation objectives are best met by establishing buffers on streams, riparian forests, wetlands, and potentially unstable slopes and landforms in order to effectively maintain key physical and biological functions until streams recover sufficiently from past disturbances to allow greater integration of revenue production and habitat conservation.

Protecting, maintaining and restoring habitat complexity afforded by natural disturbance regimes on the Western Olympic Peninsula is sufficient to support viable populations of salmonid species and other non-listed and candidate species dependent on in-stream and riparian environments.

*To operate under these hypotheses, DNR developed the following **management strategies:***

*Management strategies are based on the following **specific hypotheses**:*

Management strategies and specific hypotheses

Management strategy	Specific hypothesis
Establish interior-core buffers including protection of unstable slopes	Within each Type 3 watershed, interior-core buffers should maintain and restore habitat capable of supporting viable populations of salmonid species and other non-listed and candidate species dependent on in-stream and riparian environments when those 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 unstable channel banks and unstable slopes, *when buffers are* 4) protected from damaging winds, *and are coupled 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.
	The identification and protection of potentially unstable slopes and landforms, following section 16 of the Forest Practices Board Manual, is sufficient to prevent increases in the frequency or severity of slope failure, or any severe alteration of the natural input of large woody debris, sediment, and nutrients to the stream network.
Establish exterior buffers	As implemented, windthrow probability modeling and remote and field assessments are able to adequately identify the need for an exterior buffer. Such buffers, as identified and applied, are sufficient to protect the integrity of the interior core and the functions and processes it provides.
Protect wetlands	Protecting wetlands with buffers and special management considerations (Table IV.9., HCP p. IV.120) is sufficient to prevent net loss of wetland acreage or function.
Implement comprehensive road maintenance and abandonment plans	The implementation of comprehensive road maintenance and abandonment plans is sufficient to minimize adverse impacts to the riparian environment.

Chart A-88. Links between Working Hypotheses and Management Strategies for Northern Spotted Owl Habitat

Main management issue	How to harvest forest stands and allocate harvest activities across space and time in a way that does not appreciably reduce the chances for the survival and recovery of the northern spotted owl sub-population on the Olympic Peninsula.

DNR will manage under the following ***primary working hypothesis:***

Primary working hypothesis	DNR can meet its goals for revenue production and northern spotted owl habitat conservation in the OESF by managing through an integrated approach: no specific long-term deferrals or zones are deferred from harvest; instead, habitat thresholds are maintained at a landscape level.

	To operate under this hypothesis, DNR developed the following ***management strategies:***	*Management strategies are based on the following* ***specific hypotheses:***
Management strategies and specific hypotheses	Manage for Old Forest and Young Forest Habitat	HCP definitions for Old Forest and Young Forest Habitat meet the life history requirements of northern spotted owls.
	Maintain and restore threshold proportions of Old Forest and Young Forest Habitat in each of the 11 OESF landscapes	The minimum habitat thresholds of 40 percent Young Forest Habitat or better, of which 20 percent is Old Forest Habitat, per landscape are adequate to maintain successfully reproducing northern spotted owls.
	Rely on habitat developing in riparian areas	Spatial configuration of northern spotted habitat across the landscape maintains successfully reproducing spotted owls
	Create and maintain habitat through active management	Riparian conservation strategy makes a significant contribution to northern spotted owl habitat.
		Silvicultural treatments in forest stands will create habitat with the quality and at the rate expected in the1997 HCP.
		Northern spotted owls will respond as expected in the1997 HCP to habitat created through active management.

Tables A-44 and A-45 provide an initial list of adaptive management questions based on the specific working hypotheses for riparian areas and northern spotted owls presented in Charts A-87 and A-88, respectively. These questions are not presented in any order of priority. This list is expected to change over time as new information becomes available and new uncertainties are identified. Adaptive management questions for marbled murrelets are expected to be identified during the development of the long-term marbled murrelet habitat conservation strategy.

Table A-44. Initial List of Adaptive Management Questions for Riparian Areas

Adaptive management question 1	Do the extent and location of interior-core buffers under the draft forest land plan aid and restore riparian function?
Adaptive management question 2	Does thinning interior-core buffers, as scheduled by the forest estate model and described in the riparian procedure, result in anticipated forest conditions?
Adaptive management question 3	Is the level of protection for Type 5 streams and isolated wetlands located outside potentially unstable slopes under the draft forest land plan adequate to meet riparian conservation objectives?
Adaptive management question 4	Is the level of protection for wetlands under the draft forest land plan adequate to maintain wetland hydrologic functions?
Adaptive management question 5	Is the windthrow probability model used in the draft forest land plan effective in identifying locations susceptible to windthrow?
Adaptive management question 6	Is the threshold for acceptable windthrow risk adopted in the draft forest land plan adequate to protect the integrity of the interior-core buffer and prevent the loss of riparian function it provides?
Adaptive management question 7	How can timber be harvested in the exterior buffer without increasing vulnerability to windthrow?
Adaptive management question 8	How can wind firmness of the forest stands in the interior-core buffer be increased?
Adaptive management question 9	How effective are the screening tools used in the draft forest land plan for identifying areas with high potential for landslides?
Adaptive management question 10	How can areas with high risk of landslides be managed for wood products without increasing the frequency or severity of landslides?
Adaptive management question 11	Does the configuration of interior-core buffers through space and time allow maximum management flexibility for timber harvest?

Table A-45. Initial List of Adaptive Management Questions for Northern Spotted Owls

Adaptive management question 1	How can northern spotted owl habitat definitions in the 1997 HCP be revised to better capture northern spotted owl life history requirements and the characteristics of the forest ecosystems in the OESF?
Adaptive management question 2	How do silvicultural techniques differ in their effectiveness in creating structurally complex forest?
Adaptive management question 3	Does the amount of northern spotted owl habitat per landscape increase at the rate projected in the draft forest land plan?
Adaptive management question 4	Is the amount and spatial configuration of northern spotted owl habitat across the 11 landscapes capable of supporting successfully reproducing northern spotted owls?
Adaptive management question 5	Does the configuration of habitat through space and time allow maximum management flexibility for timber harvest?

Most of the adaptive management questions in Tables A-44 and A-45 are formulated as passive adaptive management questions because they focus on a single course of action: the implementation of management strategies in Chapter 2 of this draft forest land plan. As explained previously, testing more than one management alternative is desirable because it yields higher-quality information in less time. Given the ecological, logistical, and organizational challenges of testing multiple management alternatives, DNR will engage in few such studies in the near term. Studies that will be considered in the context of active monitoring for the near term include ongoing silvicultural trials on pre-commercial thinning, ongoing experiment in maintaining long-term ecosystem productivity, and an experimental study on alternative silvicultural techniques to maintain and restore structurally complex forest (in development) (refer to "Priority Research and Monitoring Activities in the Near-Term" later in this chapter). DNR will actively seek research partnerships and other forms of collaboration to expand the scope of adaptive management to include testing of multiple alternative management approaches in the future.

PRIORITIZE ADAPTIVE MANAGEMENT QUESTIONS

It is critical to prioritize the adaptive management questions in the initial lists presented in Tables A-44 and A-45 so that DNR focuses on those most relevant to pressing management needs in the OESF. DNR will prioritize adaptive management questions according to the prioritization criteria described in Text Box A-12. These criteria help DNR determine where to put efforts and resources first, and ensure an objective and transparent selection process.

Text Box A-12. Prioritization Criteria

1. **Linkage to future decisions**

   This criterion prompts DNR to explore whether the research and monitoring information gathered to reduce an uncertainty and answer a question is likely to influence management decisions. DNR reviews a range of possible answers and asks whether and how management practices may change according to each answer. It is important to narrow the scope of future investigation to management options that are implementable.

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

   For this criterion, DNR reviews the level of impact to revenue and conservation objectives associated with each adaptive management question or uncertainty. The level of impact is a function of the potential contribution or damaging effect that an action has and the likelihood of the impact occurring.

   The level of impact can be quantified through sensitivity analyses of proposed management actions. The amount of potentially affected resource can be identified from the management plan (for example, the number of harvested acres).

3. **The degree of uncertainty**

   The degree of uncertainty or how much is known about the system in question is best evaluated through a combination of research synthesis and expert opinion.

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

   The feasibility of getting an answer is a function of the complexity of the system in question and the time needed to obtain a response. DNR will examine the type of data needed and the time and effort required to collect it. Appropriate questions when applying this criterion are: *Can cost-effective research and monitoring techniques be developed to answer the question,* and *what degree of rigor is needed to influence future decisions, and can this be attained?*

Text Box A-12, Continued. Prioritization Criteria

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

5. **Relevance to the information needs identified in the 1997 HCP**

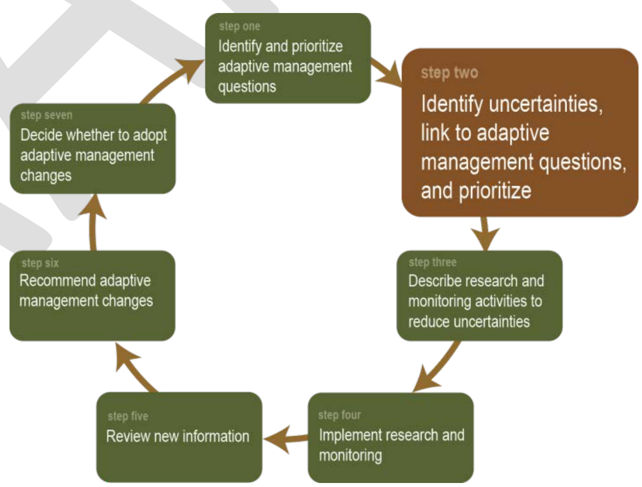
   DNR considers the relevance of each adaptive management question to the information needs specified in the monitoring and research sections of the 1997 HCP (p. V.1 through V.8) and the adaptive management section of the 1997 HCP Implementation Agreement (p. B.10 through B.11).

6. **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 or adaptive management question, that uncertainty or question 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.

Step 2, Identify Uncertainties, Link to Adaptive Management Questions, and Prioritize

The adaptive management questions in Tables A-44 and A-45 are broad and often there are several uncertainties associated with one question. Identifying a discrete set of uncertainties associated with priority adaptive management questions is an important step in developing an efficient and cost-effective research and monitoring program for the OESF. Explicitly stated uncertainties lead to development of testable research hypotheses which in turn lead to relevant research and monitoring projects.



KEY UNCERTAINTIES IDENTIFIED IN THE FOREST LAND PLANNING PROCESS

As part of this forest land planning process, DNR identified key uncertainties related to specific topic areas discussed in the OESF RDEIS and to the procedures described in this draft forest land plan. The list of these uncertainties is presented in Table A-46. Identifying these uncertainties and presenting them in this chapter is an important contribution of this draft forest land plan because it provides a fresh focus for OESF research and monitoring.

As with the list of adaptive management question in Tables A-44 and A-45, the list of uncertainties is expected to change over time. Some of these uncertainties will be reduced as new knowledge is developed and new technology becomes available. Additional uncertainties are likely to be identified during implementation and monitoring of the forest land plan.

Table A-46 updates, and in some cases specifies or clarifies, the information needs presented in the 1997 HCP, but it is not meant to be an exhaustive list of all of the uncertainties associated with natural resource management in the OESF. For example, uncertainties related to management of marbled murrelet habitat are not included in the table. Those uncertainties will be identified during development of the long-term Marbled Murrelet Habitat Conservation Strategy.

For the uncertainties associated with the economic performance of the proposed management alternatives, DNR continues to develop its understanding of key factors that drive performance. To date, DNR has conducted sensitivity analyses of timber prices, production costs, and the influence of budget levels on the overall attainment of forest land plan objectives (refer to Chapter 3 of this draft forest land plan). DNR expects to continue this work with the implementation of this forest land plan.

Uncertainties in Table A-46 are organized by major environmental topics areas. Within each topic area, uncertainties are organized by categories describing the source of the uncertainty, such as input data, ecosystem function, natural disturbance effects, or management effects. Each item in the table includes a description of the uncertainty, how that uncertainty affects planning and management, and how that uncertainty might be reduced.

Table A-46. Initial List of Key Uncertainties Identified During Development of the Draft OESF Forest Land Plan and RDEIS

Forest conditions and management	
Input data (forest inventory, geographic information system (GIS) datasets, yield tables)	DNR's field inventory of down woody debris, snags, and large trees (rare elements) has relatively low precision compared to the inventory of trees managed for future harvest. Inventory estimates of these rare elements are used in projections and assessments of habitat for species such as northern spotted owls and salmonids. Research, including exploration of recent technological advancements, is needed to improve the precision of the inventory of rare elements.
Ecosystem function and habitat needs of 1997 HCP-covered species	Decay of dead wood (snags and down woody debris) in the OESF is not fully understood. The forest estate model includes assumptions about decomposition rates in order to project the amount of dead wood over the 100-year analysis period. The model's output is used in habitat assessments for species such as northern spotted owls and salmonids. Research is needed to understand the implications of these assumptions and improve the reliability of the modeled rates of decay.
Natural disturbances effects	Current forest estate model projections of forest conditions do not account for windthrow from endemic or catastrophic winds. Wind is considered a major disturbance force in the OESF. Research and monitoring is needed to quantify the effect of endemic windthrow on forest conditions in the OESF. Large-scale catastrophic natural disturbance events (windthrow, floods, fire) are difficult to predict with any level of certainty. For many stands, impacts of these events are not likely to be affected by management and were therefore not analyzed in the RDEIS. Monitoring the effects of catastrophic disturbances through retrospective analyses or field and remote sampling may provide new evidence that might lead to changes in management.

Management effects (timber harvest and roads)	The amount of additional growth of trees retained on forest edges is not well known. The forest estate model does not account for the effect of neighboring management units on tree growth. Therefore, assumptions are made about the difference in tree growth on forest edges in order to project forest conditions. The model output was used to estimate standing volume available for harvest and habitat conditions for species such as northern spotted owls and salmonids. Monitoring is needed to evaluate the effects of forest edges on tree growth. Research is needed to develop models that account for the effect of neighboring management units on tree growth. The regeneration of trees in openings created by variable retention harvests is not well understood because the complex shape and the small size of the openings create a different growing environment than was previously typical. Competition created by stand boundaries or forest edges is modeled in the forest estate model by adjusting the FVS yields with an adjustment factor for the "edge density" of each stand. Research and monitoring is needed to assess the extent and the mechanisms through which this complexity increases competition and decreases growth of the regenerating trees.
Riparian and water quality	
Input data (forest inventory, GIS datasets, yield tables)	DNR has limited direct information on in-stream conditions such as the amount and distribution of large woody debris, the amount and spacing of pools, and the composition of the stream bed. The forest estate model and the RDEIS analyses derive the in-stream parameters from other sources (for example, Digital Elevation Model and adjacent riparian forest). In-stream conditions are used to determine the size and location of interior-core buffers and to determine the sensitivity of a stream to environmental changes. Monitoring is needed to collect empirical data on in-stream conditions and on the relationships between riparian and aquatic parameters. Identification and typing of streams in the OESF, as provided by DNR's hydrology layer for the OESF, is incomplete with some streams missing or mistyped. This is a management uncertainty that affects the implementation of the forest land plan on the ground. Research is needed to identify better methods for stream identification and typing. Information management procedures are needed to allow swift updates of DNR's hydrology layer with field data.
Ecosystem function; habitat needs of 1997 HCP-covered species	The 1997 HCP*'s* riparian conservation strategy aims to restore and maintain "habitat complexity as afforded by natural disturbance regimes." Because this concept is not fully understood, it is difficult to identify needs for habitat improvement and to measure conservation success. Research is needed to interpret this concept in more practical terms and to demonstrate how riparian systems vary in space and time. Relationships between aquatic (in-stream), riparian (near-stream), and upland conditions are not fully understood. Some of these presumed relationships are used to determine the size and location of interior-core buffers and to project in-stream and riparian conditions over time. Research and monitoring is needed to quantify these relationships. Knowledge about the habitat needs of riparian and aquatic species targeted by the OESF riparian conservation strategy is incomplete. This knowledge affects the identification of desired future conditions and the validation of riparian conservation strategy. Research is needed on habitat associations of aquatic and riparian species in the OESF.
Natural disturbances effects	The probability of endemic windthrow in the OESF is currently modeled to identify the riparian areas most susceptible to windthrow. The model output is used to identify the location of exterior buffers. Exterior buffers are placed on all segments of interior-core

	buffers for which the identified windthrow risk (a combination of the likelihood and consequence of windthrow occurrence) is deemed unacceptable. The effectiveness of this threshold to protect the integrity of interior-core buffers has to be empirically tested. For uncertainties related to large scale catastrophic disturbance events (windthrow, floods, fire), refer to "Natural disturbance effects" under "Forest conditions and management."
Management effects (timber harvest and roads)	The effectiveness of harvest practices to restore riparian habitat is not fully understood. Long-term studies examining the effects of different harvest practices on riparian systems are lacking. Research and monitoring are needed to test the assumptions about the response of riparian forest and aquatic habitat to riparian forest management in the OESF. DNR will actively manage forest stands in exterior buffers (for example, thinning and creation of canopy gaps) to increase their wind firmness. The effectiveness of the proposed techniques is not well known. Experimentation with different management techniques to increase wind firmness is needed to assess their ecological benefits as well as their economic and operational feasibility. Small headwater streams (Type 5 streams) are sensitive to shade and leaf and litter recruitment and have important delivery functions to lower-order streams. Most Type 5 streams are located on unstable slopes and therefore protected. The effectiveness of conservation measures for Type 5 streams located on stable slopes as proposed in this draft forest land plan is largely untested. Monitoring is needed to evaluate it. Roads are considered a major source of management-related stream sediment. Increased levels of fine sediment can have detrimental effects to both water quality and aquatic habitat. Fine sediment delivery is conservatively estimated in the RDEIS by examining road density, stream crossing density, proximity of roads to streams or other water bodies, and traffic use. Monitoring will help evaluate these assumptions.
Soils	
Input data (forest inventory, GIS datasets, yield tables)	Soils interact with windthrow risk, operability, and tree growth. Uncertainty exists around the site specificity of corporate GIS data on soils and slope stability. The resolution of DNR's corporate GIS data for soils and slope stability is lower than the resolution of data used for planning and operations (DNR typically uses data at the resolution of a forest management unit). Field verification of corporate datasets, specifically the United States Department of Agriculture (USDA) soils layer, by geologists and foresters and an effective data update process will help improve datasets in the future.
Management effects (timber harvest and roads)	DNR's current understanding of the effects of management activities on soil compaction, displacement, and erosion in the OESF is incomplete. Quantitative data on these effects is largely lacking. Research and monitoring is needed to quantify the relationships between management activities and soils conditions.
Northern spotted owls	
Input data (forest inventory, GIS datasets, yield tables)	The 1997 HCP definition of Old Forest Habitat often fails to identify areas known to contain older forest conditions capable of supporting northern spotted owls. Old Forest Habitat is currently delineated in part by using aerial photo interpretation. Research is needed to improve the definition to better reflect the species' habitat needs.
Ecosystem function; habitat needs of 1997 HCP-covered species	There is limited knowledge about the spatial configuration of habitat capable of supporting northern spotted owls in managed landscapes. Research (likely synthesis of studies conducted outside of the OESF) will help understand the species' landscape habitat requirements.

	The understanding of how competition with barred owls will affect northern spotted owl recovery is incomplete. The science on this topic is evolving quickly. DNR will benefit from following the new science on northern spotted owl-barred owl competition and specifically, the potential of forest management to influence this competition.
Management effects (timber harvest and roads)	The effectiveness of using silviculture in the OESF to restore and maintain habitat for northern spotted owls and their main prey (northern flying squirrels) is largely untested. The draft forest land plan for the OESF relies on active management of forest stands to accelerate the creation of structural complexity. Effectiveness monitoring is needed to test this assumption and evaluate the model projections. Recent studies show that after a thinning, including variable density thinning, northern flying squirrel populations are suppressed for several decades. Research and monitoring is needed to assess the short- and long-term response of flying squirrels and other small mammals to thinning in the OESF. Monitoring the responses of northern spotted owls' prey may become a surrogate for spotted owl validation monitoring described in the 1997 HCP given the low number of northern spotted owls on the Olympic Peninsula. Studies indicate that wide, exposed roads act as a barrier to movement of northern flying squirrel populations. Research is needed to assess the potential impacts of roads on northern flying squirrel populations.
Wildlife	
Input data (forest inventory, GIS datasets, yield tables)	For uncertainties related to field inventory of down woody debris, snags, and large trees, refer to "Input data" under "Forest conditions and management." DNR has limited data on windthrow in or near managed forested stands. This data will help inform model assumptions about the influence of management (for example, thinning or the creation of canopy gaps) on wind firmness. Retrospective monitoring is needed to provide information for model calibration and to assess the effectiveness of management practices.
Ecosystem function; habitat needs of 1997 HCP-covered species	For uncertainties related to decay of dead wood, refer to "Ecosystem function; habitat needs of 1997 HCP-covered species" under "Forest conditions and management."
Natural disturbances effects	For uncertainties related to windthrow from endemic or catastrophic winds, refer to "Natural disturbance effects" under "Forest conditions and management." For uncertainties related to large scale catastrophic disturbance events (windthrow, floods, fire), refer to "Natural disturbance effects" under "Forest conditions and management."
Management effects (timber harvest and roads)	For uncertainties related to tree growth on forest edges, refer to "Management effects" under "Forest conditions and management."
Fish	
Input data (forest inventory, GIS datasets, yield tables)	For uncertainties related to limited direct information on in-stream conditions, refer to "Input data" under "Riparian and water quality." For uncertainties related to identification and typing of streams, refer to "Input data" under "Riparian and water quality."
Ecosystem function; habitat needs of 1997 HCP-covered species	For uncertainties related to habitat complexity, refer to "Ecosystem function; habitat needs of 1997 HCP-covered species" under "Riparian and water quality."

Natural disturbances effects	DNR's current understanding of natural disturbances and the historic range of variability in riparian and in-stream conditions is still evolving. Information on how riparian systems vary in space and time is an emerging science and is certain to develop over time. Monitoring of managed and unmanaged watersheds will help quantify the range of natural variability on the western Olympic Peninsula. Closely following the new science on this topic will provide context for these findings.
Climate change	
Ecosystem function; habitat needs of 1997 HCP-covered species	The extent to which climate change will affect Pacific Northwest forests is largely unknown. Research and monitoring is underway globally to assess potential problems with tree growth, phenology, reproduction, and tree health. DNR needs to follow the global scientific development on this topic in order to develop informed adaptation and mitigation strategies. For uncertainties related to decay of dead wood, refer to "Ecosystem function; habitat needs of the HCP-covered species" under "Forest conditions and management." DNR's estimates of carbon sequestration in the OESF are based on limited data about the rate of carbon sequestration in different tree productivity zones. In addition, there are uncertainties in DNR's assumptions about the type of products that will be made from wood harvested from state trust lands, which may affect the amount of carbon that will be sequestered in these products. Research is needed to fill knowledge gaps about carbon budgets of OESF forest stands.

LINK UNCERTAINTIES TO ADAPTIVE MANAGEMENT QUESTIONS

Each of the adaptive management questions presented in Tables A-44 and A-45 has one, or often several, uncertainties. Adaptive management questions will be linked to the uncertainties identified in Table A-46. An example is provided in Table A-47.

Table A-47. Example of Uncertainties Related to Riparian Adaptive Management Question 1

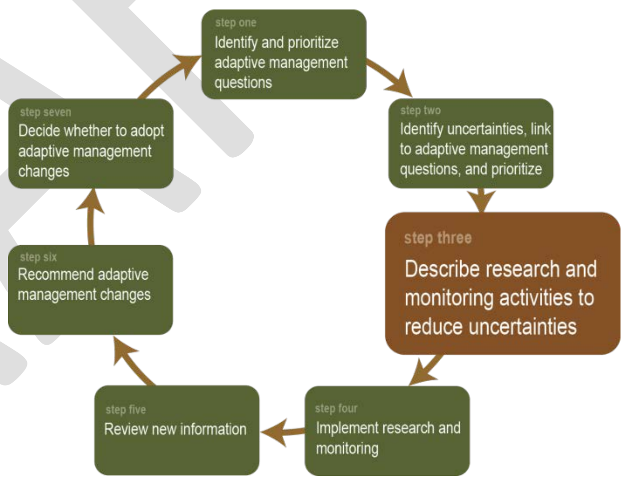
Adaptive management question 1	**Do the extent and location of interior-core buffers under the draft OESF forest land plan aid and restore riparian function?**
Identified uncertainties	Incomplete information on stream location and conditions
	Limited information about the relationships between riparian, upland, and stream conditions
	Inadequate understanding of desired future condition (the concept of "habitat complexity as afforded by natural disturbances")
	Untested model projections for additional tree growth at forest edges

Not all of the uncertainties in Table A-46 will be linked to adaptive management questions because some uncertainties are not appropriate for reduction through DNR's adaptive management process. The focus of the adaptive management process for the OESF, according to the definition presented at the beginning of this chapter, is "improvement of management practices," which DNR interprets as finding better ways to integrate revenue production and ecological values. Therefore, if reducing an uncertainty is not likely to contribute to this, DNR will not address it in an adaptive management context. An example is studying large-scale catastrophic disturbance events such as windthrow. The random nature of these disturbances makes them difficult to predict and plan for, and the opportunity to minimize their effect through forest management is limited. Other uncertainties, although directly related to management improvement, are more effectively addressed outside a formal adaptive management process. For example, the issues around identification and typing of streams are more effectively resolved through improved information management such as an established process for updating the hydrology data with field information collected during timber sales layout.

PRIORITIZE UNCERTAINTIES

Once the uncertainties have been linked to adaptive management questions, DNR then prioritizes the uncertainties according to the criteria in Text Box A-12. The goal, as in the case with prioritization of the questions, is to address the most pressing management needs first. As part of this prioritization, DNR also considers whether the uncertainty affects multiple management questions. For example, the limited direct information on in-stream conditions affects questions related to the extent and location of interior-core buffers, the protection of Type 5 streams not associated with unstable slopes, and hydrologic response to watershed-level management. Relevance to multiple management questions elevates the importance of the uncertainty.

Step 3, Describe Research and Monitoring Activities to Reduce Uncertainties



In this step, DNR develops specific research and monitoring projects to reduce the uncertainties identified and prioritized in Step 2. To complete this step, DNR first develops a scoping paper. Once the scoping paper and necessary funding have been approved, DNR develops a study plan which includes testable hypotheses, a detailed study design, field protocols, and analytical methods. The study plan also describes how results may inform future management decisions. Selection of field sites will require 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 will rely on a Science Advisory Group to review and, in some cases, develop study plans. In addition, the Science Advisory Group may advise DNR in identifying thresholds that will trigger management responses. Membership in this group will not be permanent; participating experts will be carefully selected for each project based on their professional credentials in a particular subject area.

In most cases, the results of a research and monitoring project will be produced and considered by decision makers in more than one adaptive management cycle. This is especially true for slowly changing systems such as forests.

TYPES OF MONITORING TO BE USED IN THE OESF

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

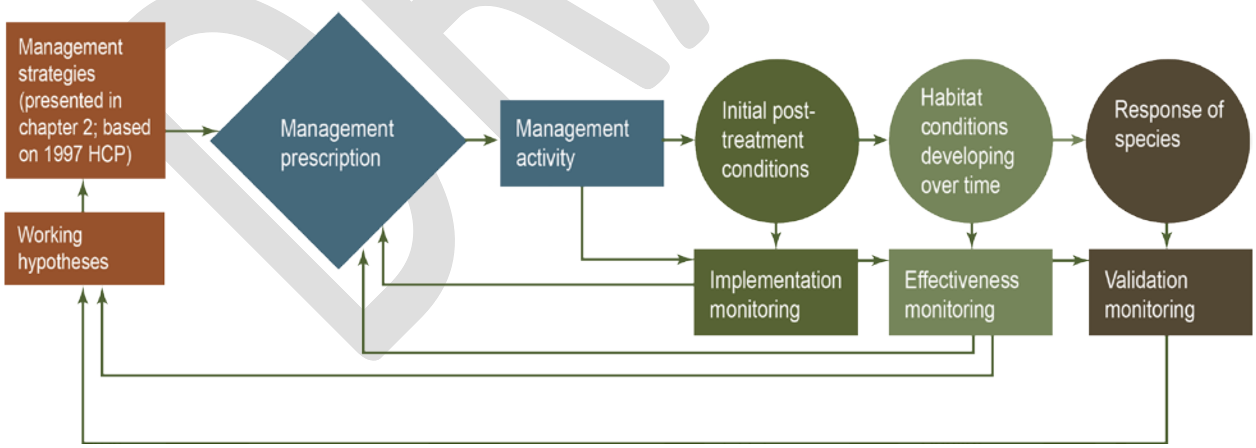
- **Implementation monitoring**, used to determine whether the 1997 HCP conservation strategies are implemented as written;
- **Effectiveness monitoring**, used to determine whether implementation of the conservation strategies results in anticipated habitat conditions; and
- **Validation monitoring,** 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.

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 1997 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. Also, monitoring terminology differs among organizations.

Different types of monitoring involve different levels of complexity, and all three types above 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 A-9 shows the relationship between the three types of monitoring and their effect on forest management.

Figure A-9. Relationship between Implementation, Effectiveness, and Validation Monitoring and Forest Management

Modified From Wilhere and Bigley 2001



- **Management prescriptions** are written for management activities such as silvicultural treatments or road building. Those prescriptions are based on management strategies (refer to Chapter 2), which are based on the conservation strategies in the 1997 HCP. Refer to “Identify and Prioritize Adaptive Management Questions and Link Them to Future Management Decisions” earlier in this chapter for more information on working hypotheses and strategies.

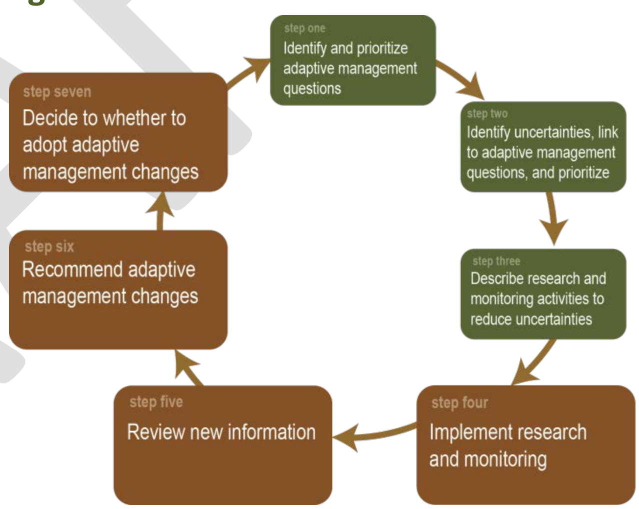
- After a **management activity** has been conducted, DNR evaluates it through **implementation monitoring**. DNR evaluates whether or not the activity is implemented as described in the prescription, and whether the **initial post-treatment conditions** are in compliance with the requirements of the 1997 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. For example, DNR monitors the rate at which stands treated with variable density thinning develop into Old Forest Habitat. 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 abundance of flying squirrels (northern spotted owls' primary prey species) in response to a variable density thinning. 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.

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.



Step 5, Review New Information

In Step 5, DNR reviews and interprets research and monitoring findings from Step 4, as well as other scientifically-credible information provided by outside sources. The Science Advisory Group will peer-review externally-produced information and reports from DNR projects. The members of the Science Advisory Group may be asked to explain results to DNR managers.

Step 6, Recommend Adaptive Management Changes to Decision Makers

An Adaptive Management Advisory Group consisting of division and region managers will be tasked with formulating the adaptive management recommendations. These recommendations, which will be presented to DNR decision makers, will be based on the findings from Step 5 but will also consider the economic and social consequences and operational feasibility of potential changes. The membership and responsibilities of this group, as well as the responsibilities of decision makers, are described in the adaptive management procedure in Appendix A-3 of this draft forest land plan.

Step 7, Make Decisions on Adaptive Management Changes and Implement

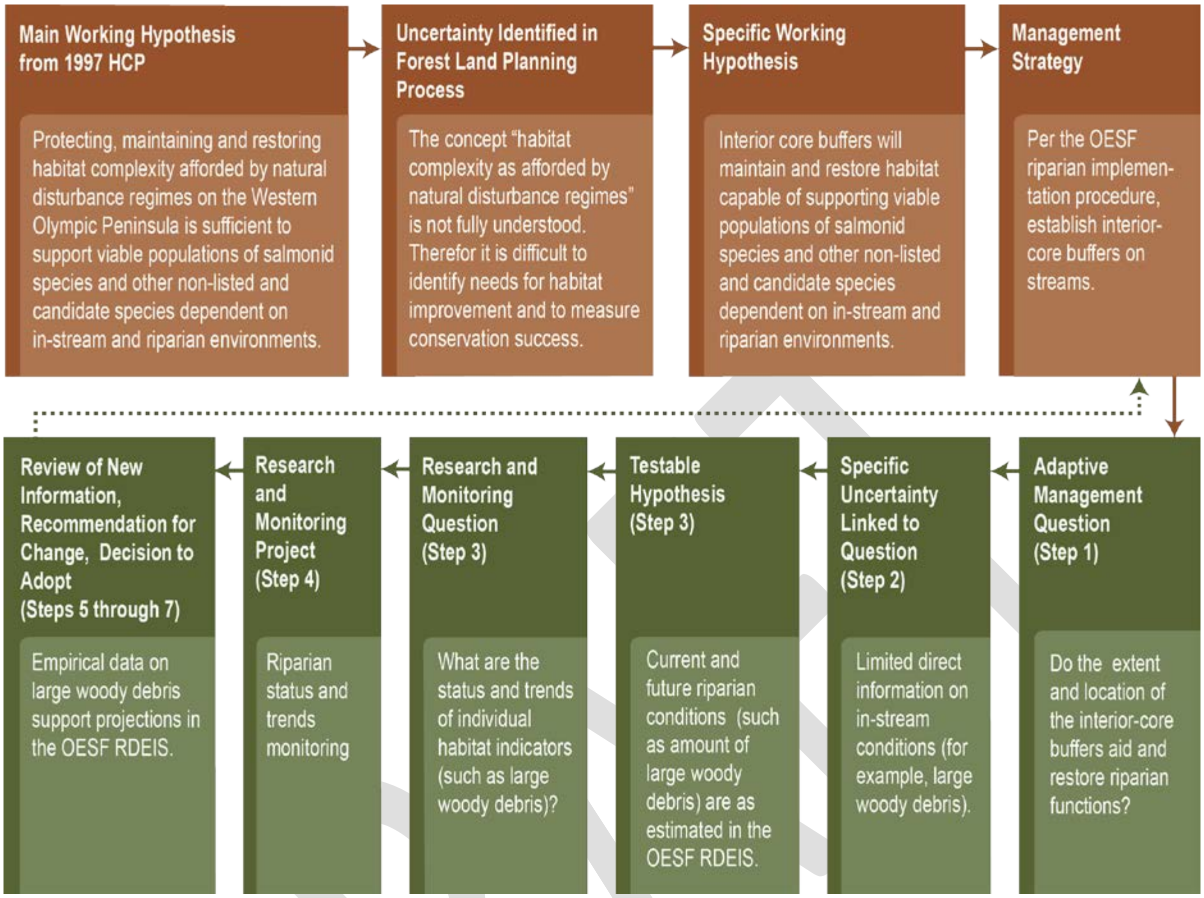
Decision makers will decide whether to adopt proposed adaptive management changes. Potential changes may include an update or amendment to a policy or planning document (for example, the 1997 HCP or this draft forest land plan, respectively), new or updated procedures (for example, Forestry Handbook procedures), change in operational guidelines, new or updated training in natural resource management, or organizational changes. Some of these changes will require SEPA review. The decisions and their rationale are documented in formats such as memos and meeting notes and then archived. This information will be included in the information management process (refer to Appendix A-1).

If adaptive management changes are adopted, DNR decision makers will ensure DNR has the financial means and organizational structure to implement them.

Putting it All Together: An Example

In Figure A-10, DNR provides an example to demonstrate how the adaptive management process works. In the blue boxes, DNR shows the progression from a main working hypothesis in the 1997 HCP to a management strategy. The green boxes show the progression of an adaptive management question through the adaptive management process, and how information gathered through that process may lead to changes in the working hypothesis and strategy. The steps shown in the green boxes refer to steps in the adaptive management process.

Figure A-10. Working Hypotheses, Strategies, and the Adaptive Management Process



Lessons Learned, Expected Challenges, and Proposed Solutions

DNR's history with adaptive management, monitoring and research in the OESF was discussed earlier in this chapter. Following, DNR reviews adaptive management efforts made by other agencies and discusses lessons learned, expected challenges, and proposed solutions.

Insights from Other Forest Managers in the Pacific Northwest

DNR reviewed the adaptive management programs of regional land managers to learn from their experience in implementing adaptive management. The following review includes British Columbia's Coast Forest Strategy (formerly The Forest Project)[5] and the Northwest Forest Plan.[6] Field implementation of these programs did not start until the 1990s. Because of the slow response of natural systems and the complexity introduced by large spatial scales, there has not been enough time to report big shifts in management due to research and monitoring findings; however, it is still possible to evaluate the effectiveness of these programs.

British Columbia's Coast Forest Strategy is an internationally recognized success story for combining sustainable resource management and biodiversity conservation. Its success is attributed in part to continued support by senior management and corporate commitment (Smith 2009). Another strong reason for success is a rigorous research and monitoring program which engages numerous external scientists. And finally, the thoughtful and active engagement of stakeholders since the early stages of the process likely contributes to the success of this adaptive management program (Baker 2011).

A 10-year review of the Northwest Forest Plan's (Plan) adaptive management program found some successes. The adaptive management process as applied in several important management studies helped shift Plan policy, particularly commercial thinning in late-successional reserves to speed habitat development and produce wood. The single greatest success was the institutionalization of a formal interpretive step that led to immediate decisions (Bormann and others 2007). However, a host of barriers—institutional inertia, lack of organizational capacity, absence of leadership, and inadequate resources—constrained adaptive management efforts (Haynes and others 2006). High expectations for Adaptive Management Areas were largely unmet for a variety of reasons including a lack of regional management flexibility. Regional monitoring produced important information, but questions were not linked well to potential decisions.

This overview shows that, for the most part, the identified obstacles were organizational, fiscal and/or social.

Expected Challenges to Adaptive Management in the OESF and Proposed Solutions

Some of the challenges listed in the following section are inherent to the adaptive management of natural resources and therefore are universal to any organization managing natural resources. Other challenges, such as the research and monitoring funding mechanism, are specific to DNR.

Embracing Uncertainty

The concept of continuous change is difficult for forest managers, conservation groups, government agencies, and other parties interested in forest management (Lindenmayer and Franklin 2002). These groups typically seek certainty in management outcomes (Walters 1986).

In this chapter, DNR recognizes and explicitly states the uncertainties identified during the forest land planning process. The adaptive management process in the OESF will enable DNR to reduce the uncertainties associated with its management strategies and apply the knowledge gained to future management decisions.

Long Adaptive Management Cycle

Natural systems often respond slowly to treatment. Depending on the nature of the question being asked, it may take decades to obtain reliable answers to adaptive management questions. This long adaptive management cycle presents three major, inherent challenges: 1) institutional memory loss and scope-creep, 2) a reluctance to commit funding or support for long-term studies because managers need immediate answers to currently pressing questions, and 3) a budget cycle not conducive to funding long-term projects.

DNR intends to address the first challenge by improving information management and designating staff to conduct programmatic work, such as establishing research partnerships, outreach and data stewardship. More details are provided in Appendix A-1. DNR intends to address the second challenge by prioritizing the adaptive management questions and uncertainties described earlier in this chapter; prioritization should ensure that long-term projects are considered if they are given a high priority. For the third challenge, DNR is currently discussing a new funding mechanism for the OESF Research and Monitoring Program to ensure a more stable level of funding (refer to “Funding and Sustained Attention” later in this chapter). DNR recognizes that providing stable funding will be an on-going challenge.

Large Spatial Scales and Ecological Variability

Large spatial scales, biophysical and ownership constraints for experimentation, and detection of changes in populations that are spatially and temporally variable can present overwhelming challenges.

The key to overcoming these difficulties is to build partnerships with external research organizations that offer scientific expertise and technology. Recent steps include the 2009 Memorandum of Understanding for OESF inclusion in the Forest Service Experimental Forest and Range Network, and DNR’s research partnership with the USFS Pacific Northwest Research Station on the project “Status and Trends Monitoring of Riparian and Aquatic Habitat in the OESF” which started in 2012.

Experimentation Hindered by Precaution

Although this problem is not as pronounced in the OESF as it is on federal lands, some experimental studies in the OESF have been delayed or avoided because of their perceived risk to sensitive ecosystem features. An example is experimental design of exterior buffers (DNR 1997, p. IV.117). DNR’s intention is to continue exploring this and other innovative forest practices as a tool to integrate revenue production and ecological values.

Effective communication with interested stakeholders is the key to obtaining their support for testing new management strategies. Early stakeholder involvement in a study’s planning stage helps DNR understand and consider stakeholder input, and also helps stakeholders understand the risks and benefits of proposed experimentation. Effective communication should distinguish between avoiding or preventing any risk, and avoiding or preventing serious or irreversible risk (Jacobson and others 2009). The risk of not obtaining new knowledge should also be discussed.

Programmatic Approach

One of the main reasons for the limited success of adaptive management in the OESF has been the lack of a programmatic approach. Most of the research and monitoring in the past was conducted on a project-by-project basis. The final steps of the adaptive management cycle (interpretation of results, recommendation to decision makers, and decisions to adopt adaptive management changes) often did not take place.

This draft forest land plan for the OESF provides the conceptual foundation for a programmatic approach by specifying working hypotheses and uncertainties, linking them to main adaptive management questions, and identifying priority research and monitoring activities in the near term (refer to "Priority Research and Monitoring Activities in the Near Term" later in this chapter). In addition, DNR included an adaptive management procedure in this plan to aid the institutionalization of the process (refer to Appendix A-3). DNR is discussing the organizational structure and funding mechanism of the OESF Research and Monitoring Program.

Funding and Sustained Attention

Providing adequate funding for research, monitoring, and adaptive management is a universal problem in natural resource management (Lindenmayer and Franklin 2002, Lindenmayer and Likens 2010). Obtaining sufficient resources for, and sustaining organizational commitment and attention to, long-term studies and adaptive changes is the greatest challenge to an adaptive management program (Franklin 2005, Larsen and others 2004).

One of the purposes of identifying adaptive management questions and uncertainties and linking them to specific projects in this chapter is to help maintain focus. Also, with the development of DNR's adaptive management procedure (refer to Appendix A-3), DNR seeks to institutionalize the adaptive management process and to sustain its attention on main adaptive management questions.

As a government organization, DNR operates on a biennial budget, and the funding for the OESF Research and Monitoring Program is decided every two years. Currently, the program is funded through allotments from the Resource Management Cost Account and Forest Development Account. Management funds are dependent on revenue generated from timber sales, land leases, and agricultural lease agreements. The overall expenditures from these accounts must support generation of revenue to trust beneficiaries in both the short and long term.

Potential fluctuations in funding make it difficult to secure funding and staff for long-term projects, coordinate between projects, maintain non-project activities such as information management, and engage in research partnerships with external organizations.

DNR is continually exploring alternative ways to provide a more stable, OESF-dedicated funding source for the OESF Research and Monitoring Program. For example, DNR actively continues to seek external funding through collaborative research and monitoring projects and grant applications.

Priority Research and Monitoring Activities in the Near-Term

DNR identified the following seven research, monitoring, and information management activities as high priorities to implement in the OESF in the near term (next five years):

- OESF information management
- HCP implementation monitoring
- Status and Trends Monitoring of Riparian and Aquatic Habitat in the OESF

- Silvicultural experimentation to develop structurally complex forest
- Pilot validation monitoring for the HCP riparian conservation strategy
- Cooperative silvicultural research
- Long-term Ecosystem Productivity

Some of these projects have been on-going for several years (for example, HCP implementation monitoring). Others have started recently (for example, status and trends monitoring) and some are new proposals (for example, pilot validation monitoring). As DNR engages in a formal adaptive management process (as described earlier in this chapter), new projects likely will be added to the list. Each project is briefly described in the following section; details are provided in Appendix A-1 (Information Management), A-4 (Implementation Monitoring) and A-5 (Riparian Validation Monitoring).

OESF Information Management

Information management includes documenting activities, standardizing the level of detail recorded, specifying the update and archival processes, and making records easily accessible to staff and external partners.

Information management is one of the six management processes recommended to realize the experimental vision of the OESF (DNR 1997, p. IV.85). Information management is important because of two unique characteristics of the OESF. First, the greater management flexibility allowed at the stand and landscape level requires tracking of ecological conditions at different spatial scales and documenting the rationale for site-specific management decisions. Second, the adaptive management process described in this chapter is critically dependent on effective information management: in order to "learn from doing," it is necessary to know what has been done and why. In addition, the OESF adaptive management process requires acquiring and utilizing information from a wide range of sources (management operations, monitoring, or research) both internally and from other organizations.

OESF information needs are identified in the following broad categories:

- **Implementation of the forest land plan**
  The procedures in Appendix F of the OESF RDEIS require DNR staff to use a variety of information sources to make site-specific management decisions.
- **Monitoring the implementation of the forest land plan**
  This is the commitment for implementation monitoring described in the 1997 HCP.
- **Monitoring habitat conditions and species response to management**
  This is the commitment for effectiveness and validation monitoring as described in the 1997 HCP.
- **Re-runs of the forest estate model and updates of the forest land plan**
  Future updates will require updated information on operations that have been conducted and the resulting habitat conditions, as well as the latest knowledge on ecological processes.
- **Implementation of the adaptive management process**
  A successful and effective adaptive management process relies on documentation of what information was considered and how decisions were made at each step.

Descriptions of information needs, required format, and responsible parties needed for robust and effective information management in the OESF are presented in Appendix A-1.

Information management is a technically and organizationally challenging task for large institutions such as DNR, especially considering the long-term research and monitoring projects envisioned in the 1997 HCP. It is also a significant financial investment. In their review of long-term monitoring programs in forest management, Lindemayer and Franklin (2002) suggested that data management should average 20 to 25 percent of the research and monitoring program budget.

HCP Implementation Monitoring

The 1997 HCP directs DNR to report on the implementation of conservation strategies annually (DNR 1997, p. V.9). The report's "scope and level of detail" should be sufficient to permit the Federal Services to confirm that DNR is implementing the conservation strategies as written.

In addition to demonstrating compliance with the 1997 HCP, data from OESF implementation monitoring is needed for:

- **Effectiveness and validation monitoring and research**
  Information on completed activities and their assessment will be used to characterize baseline ecological conditions, coordinate research and monitoring activities with operations, and conduct retrospective studies such as effectiveness of exterior buffers.
- **Adaptive management**
  Findings of non-compliance and their causes will be used to continuously improve management.
- **Re-runs of the forest estate model**
  Updates on completed activities and ecological conditions will improve the model input data.
- **Communication with DNR stakeholders and research partners**
- **Reports of other DNR programs such as Sustainable Forestry Initiative (SFI) certification**

As DNR implements the plan, it will rely on improved information management for office audit of completed timber harvest and silvicultural activities in the OESF. DNR also expects to increase its use of remote sensing data and technology (as it becomes available) to collect and analyze a sample of implemented conservation strategies. More information on the implementation monitoring approach in the OESF and its organization and funding is provided in Appendix A-4.

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

Implementation of this forest land plan is expected to improve riparian conditions in the OESF over the long term (refer to "Riparian" on p. 3-45 of the OESF RDEIS). DNR has developed a long-term plan for monitoring in-stream and riparian conditions across the OESF and for evaluating habitat projections. In addition to gathering observational data, inferences will be made about management effects on riparian and aquatic habitat across the OESF through an analytical approach called "model-based inference" (Anderson 2008).

Assessing the status and trends of riparian and aquatic habitat will reduce a number of the uncertainties identified in Table A-46. Specifically, it will provide direct information on in-stream conditions; data to test presumed relationships between riparian, upland, and in stream-conditions; and information to better define the 1997 HCP term “riparian habitat complexity.” Finally, the empirical data collected through this project will be used to characterize baseline habitat conditions and habitat variability for future riparian validation monitoring.

A study plan and 2012 establishment report for this project are available at DNR’s website at http://www.dnr.wa.gov/ResearchScience/Topics/TrustLandsHCP/Pages/lm_hcp_oesf_research_interest.aspx. Following is a summary of project activities to date.

DNR staff developed a study plan in 2011. It calls for long-term (at least 10 years) monitoring of 50 Type-3 watersheds representative of riparian conditions across the OESF. The study plan calls for sampling seven aquatic habitat indicators such as stream temperature, shade, and discharge, and two riparian habitat indicators such as microclimate and riparian vegetation at the outlet of each watershed. In July 2012, DNR provided funding of $145,000 for implementing the plan during FY 2013. The same amount of funding was approved for FY 2014 and FY 2015. Project implementation started in August 2012, with GIS and field reconnaissance of the selected watersheds. By the end of FY 2013, all watersheds were permanently marked, and water and air temperature data loggers were installed in each sample stream reach. Stream gage stations were installed in 14 watersheds. Microclimate transects, with data loggers continuously recording air temperature and humidity, were initiated in 10 watersheds. DNR field crews are collecting data on stream morphology, large woody debris, habitat units, and shade. 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

Experimentation with innovative silvicultural techniques was a major impetus for designating the OESF. The intent was to use new harvest and regeneration methods as a tool to integrate revenue production and ecological values.

The draft forest land plan for the OESF relies on active management of forest stands to accelerate the development of structural complexity. The percentage of acres in the Structurally Complex stand development stage is expected to increase over the 100-year analysis period (refer to “Forest Conditions and Management” on p. 3-21 of the OESF RDEIS). The number of acres that provide support for northern spotted owl life history requirements is also projected to increase (refer to Chapter 3 of the draft forest land plan and to “Northern Spotted Owls” on p. 3-203 of the OESF RDEIS). The effectiveness of the proposed silvicultural regimes to develop and maintain structurally complex forests, specifically spotted owl habitat, is identified as an uncertainty in Table A-46. As DNR implements this forest land plan, it expects to develop silvicultural experimentation to test working hypotheses around forest growth and development.

Pilot Validation Monitoring for the Riparian Conservation Strategy

Riparian validation monitoring, which is to occur only in the OESF, is a 1997 HCP commitment (p. V.2). Through riparian validation monitoring, DNR will document salmonid habitat use and test the underlying assumptions of the OESF riparian conservation strategy. Incomplete knowledge about the habitat needs of riparian and aquatic species, and specifically salmonid species, is identified as an uncertainty in Table A-46.

A series of workshops involving DNR staff and the Federal Services was held in 2008. The objective of these workshops was to develop a systematic approach to, and suggest spatial scales and indicators for, riparian validation monitoring in the OESF. Information from these workshops was used to develop a framework for riparian validation monitoring in the OESF (refer to Appendix A-5).

Given the complexity and cost of this project, DNR is taking a three-phase approach: an assessment phase, a pilot study, and full implementation (refer to Chart A-89 later in this chapter). Each phase is dependent on budget availability and partnership with external research organizations. DNR is exploring collaboration options with the USFS Pacific Northwest Research Station and University of Washington Olympic Natural Resources Center.

Cooperative Silvicultural Research

Two long-term studies conducted through DNR's participation in silvicultural research cooperatives (co-ops) have installations in the OESF. These studies are replicated regionally and have broad management implications. In addition, they provide information relevant to specific OESF management questions. 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).

The first study, conducted by the Stand Management Co-op (based at University of Washington), is investigating the performance of Douglas-fir in relation to a wide range of spacing and density levels. In relation to 1997 HCP objectives, the study is investigating crown and branch development, tree stability, and growth and yield in relation to spacing. Also being studied are the effects of growing space on tree and stand development and characteristics. 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.

The second study, conducted by 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 to develop techniques for planting and managing alder successfully. Study plots were installed in 1991 and 1996 and are re-measured at 3 to 5 year intervals. The study has been replicated at 26 locations on multiple ownerships across the Pacific Northwest.

Long-Term Ecosystem Productivity Study

The OESF is host to one of four replicates of the Long-term Ecosystem Productivity Study, 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 1997. Silvicultural treatments included clear-cutting, leaving woody debris, thinning to accelerate late-seral development, favoring early-successional species, and planting monocultures of the commercial timber species Douglas-fir. Re-measurements of the plots started in 2012.

This study provides an unprecedented opportunity to identify, evaluate, and understand emerging above- and below-ground responses to multiple disturbances over multiple decades. Specifically, the study contributes to understanding of the following issues:

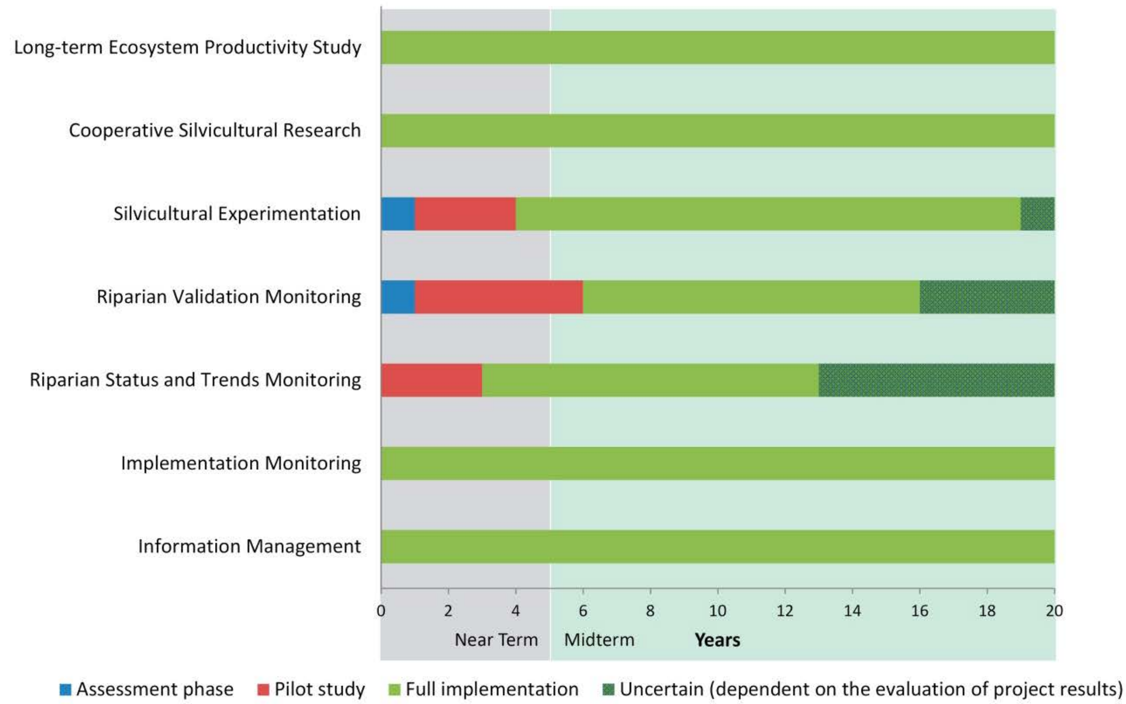
- Sequestering carbon, specifically the dynamics of both above- and below-ground carbon pools in response to disturbance, and the strong linkages between the above- and below-ground components of forests;
- Restoring productive capacity after disturbance and maintaining it over the long term;
- Testing the effectiveness, in terms of stand structure and species diversity, of different silvicultural techniques in developing late-successional habitat; and
- Developing new silvicultural prescriptions that can increase resilience as a strategy to adapt to climate change.

Estimated Timeline for Priority Research and Monitoring Activities in the Near Term

Chart A-89 shows the timeline for implementing different stages of the projects described in this section. Several phases are identified in each project's implementation: 1) the assessment phase, which precedes the development of the study plan (for example, the validation monitoring workshops organized by DNR in 2008 that assessed appropriate spatial scale and response variables); 2) the pilot study, which evaluates feasibility, time, cost, and statistical variability to improve upon the study design; and 3) the full implementation phase. The part of the timeline marked as uncertain refers to a point in time when the project results are assessed and a decision is made on whether they are useful enough to continue the study.

The graph shows the duration of projects in the near term (approximately five years) and midterm (approximately 6 to 20 years). As indicated in Chart A-89, some of these projects are on-going, while others are new.

Chart A-89. Duration of High Priority Research and Monitoring Activities in the Near Term and Midterm



Other Elements of OESF Research and Monitoring Program

Outreach and Communication

The involvement of stakeholders, tribes, research partners, and the general public is an important component of successful adaptive management. As part of outreach, DNR expects to inform and educate the public about individual projects and management changes and invite their comments, concerns, and opinions. In addition, DNR expects to provide opportunities for public involvement in the OESF adaptive management process. Formal avenues include the SEPA process, meetings of the Board of Natural Resources, and public meetings. Less formal opportunities may exist for volunteer involvement in research and monitoring projects and for comments on periodic monitoring reports and proposed management changes.

Research Partnerships

Research and monitoring in the OESF is to be conducted through partnerships with external research organizations (DNR 1997, p. IV. 86). DNR has used different partnership models over the years ranging from contracts on specific projects to long-term cooperatives. Below is an example of DNR participation in silvicultural research co-ops.

Silvicultural Research Co-ops

DNR participates in several long-term, regional silvicultural research co-op studies investigating forest stand development and dynamics. For over 40 years, silvicultural research co-ops have been actively investigating stand development in relation to a wide-range of influences including growing space, species composition, nutrition, pre-commercial and commercial thinning, reforestation, vegetative competition, and genetics. Recently, specific research into the interactions between silvicultural treatments, genetics, climate change, and sustainability have entered the scope of co-op research through improved site characterizations and linking of process-based and mensurational growth models.

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. Co-ops pool the financial, analytical and operational resources of many members, thus enabling them to participate in long-term, regionally replicated studies beyond the scope otherwise possible for a single organization.

Co-op studies improve DNR's understanding of the fundamental growth dynamics of trees in relation to growing space and other considerations, allowing DNR to devise innovative silvicultural approaches to create the complex stand structures that define northern spotted owl habitat. Furthermore, the growth models developed in these types of studies enable DNR to forecast future stand development, which is necessary to achieve the integration of revenue production and ecological values in the OESF. Co-op studies also help develop and refine various upper-level modeling approaches to understanding the cumulative or landscape-level impacts of forest management activities.

In most cases, Co-op research is underpinned by field studies 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.

Funding and Organizational Structure

Below is summary of DNR's funding commitments for research and monitoring as described in the 1997 HCP, and a description of the current funding mechanism for the OESF Research and Monitoring Program.

Funding research and monitoring is a requisite part of maintaining an incidental take permit (USFWS and NMFS 1996). DNR is committed to requesting from the Washington State Legislature at least $1 million per year for research until priority research questions, as identified in the 1997 HCP, are adequately addressed. Partnerships and external grants are expected to strengthen the core financial base provided by DNR (DNR 1997, p. V.9).

As mentioned previously, DNR's funding for research and monitoring and adaptive management in the OESF is determined as part of the DNR's biennial budget. In addition to the internal funding base, DNR will continue to actively seek external funding through collaborative research and monitoring projects and grant applications.

[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).

[2] Active management includes planting trees, managing vegetation, thinning forests, and performing stand-replacement harvests.

[3] Quasi-experimental design has two of the key elements of a true experimental design: replication and control. But it lacks the third element: random assignment of treatments.

[4] A draft adaptive management procedure that institutionalizes the OESF adaptive management process was developed during this planning process (refer to Appendix A-3 of the RDEIS). This draft procedure identifies responsible parties for each step in the process, assigns responsibilities, and specifies timelines for moving through the steps.

[5] The commitment for adaptive management to sustain profitable business and biodiversity started in 1998 under the tenure of the company MacMilan Bloedel, subsequently owned by Weyerhaeuser, then Cascadia Forest Products, and now led by Western Forest Products.

[6] The federal *Northwest Forest Plan* pioneered efforts to make adaptive management a fundamental way of managing forestlands given the uncertainties with the chosen management strategies (Forest Ecosystem Management Assessment Team [FEMAT] 1993).

Chapter 5

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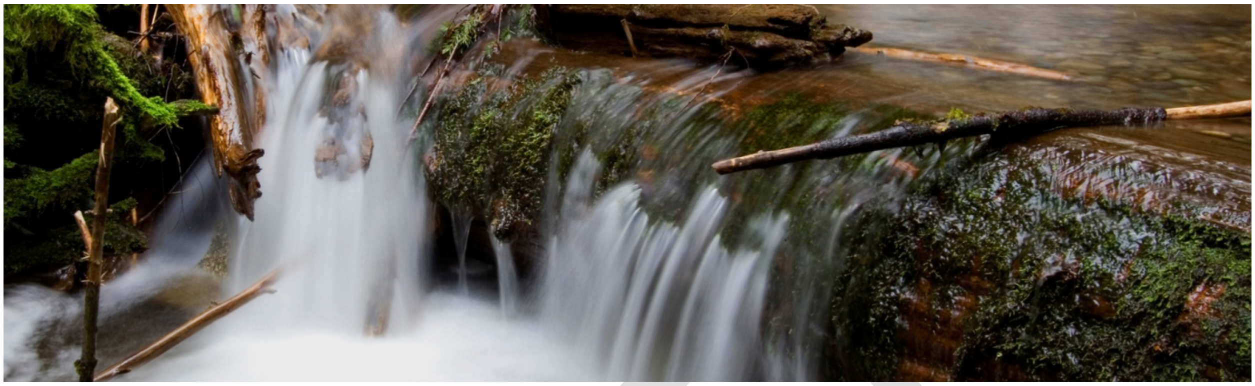

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